UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XI.

REPORT

OF

THE COMMISSIONER

FOR

1883.

A.—INQUIRY INTO THE DECREASE OF FOOD-FISHES.
B.—THE PROPAGATION OF FOOD-FISHES IN THE WATERS OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1885.

Resolved by the Senate (the House of Representatives concurring), That the report of the Commissioner of Fish and Fisheries for the year 1883 be printed, and that there be printed 10,000 extra copies, of which 2,000 shall be for the use of the Senate, 6,000 for the use of the House of Representatives, 1,500 for the use of the Commissioner of Fish and Fisheries, and 500 for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication and 10 per cent thereto thereon added, the illustrations to be obtained by the Public Printer, under the direction of the Joint Committee on Public Printing.

Agreed to by the Senate May 14, 1884.

Agreed to by the House June 6, 1884.

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* In Tanner's Report on the Work of the Albatross.
† In Lundberg's Eel Fisheries.
‡ In Atwater's Report on the Chemical Composition of Fish and Invertebrates
§ In Verrill's Results of the Albatross Explorations in 1883.

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* In Shufeldt's Osteology of Amia calva.

† In Eisen's Oligochætological Researches.

‡ In Seal's Aqua-Vivarium as an Aid to Biological Research.

§ In McDonald's Report of Central Station.

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* In Wood's and Kite's Spanish Mackerel Papers.

† In Benecke's Utilizing Water by Fish-Culture.

‡ In True's Suggestions to Light-House Keepers and others, relative to collecting specimens of whales and porpoises.

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REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

I.—INTRODUCTORY REMARKS.

The present volume (for 1883) constitutes the eleventh of the series of annual reports of the work of the United States Fish Commission as ordered by Congress, and is intended to give an account of the proceedings of the Commission in its various divisions.

With the completion of the buildings at Wood's Holl the Commission hopes to be ready to carry out, on such scale as may be authorized by Congress, the various functions intrusted to it.

With the acquisition, with the means provided by Congress, of steamers capable of carrying on work in the ocean, as well as in the interior waters, the possibilities of usefulness have become greatly extended, and much has been attempted as well as accomplished. In addition to the regular work of the Commission, it has become possible to do a great deal for the advancement of science in general, especially by prosecuting researches into the general natural history of the aquatic animals and plants, either by persons officially connected with the Commission or by specialists to whom the facilities of the service are extended in the way of the use of boats, stations, and material.

The Commission has also made very large collections of aquatic animals, especially of fishes, shells, corals, crustaceans, starfishes, &c., and after submitting them to a careful investigation for monographic research, and setting aside a full series for the National Museum, the remainder has been made up into well identified and labeled sets for distribution to colleges, academies, and other institutions of learning throughout the United States. The educational advantages of this last measure have proved to be of the utmost value, and are thoroughly appreciated by teachers throughout the country. Applications for these sets are being continually received, and several hundreds of them have already been supplied, a number of persons being occupied for a good part of their time in preparing to meet additional calls. There is nothing that so much increases the interest in natural history as the opportunity of examining actual specimens of rare and usually unprocurable species, instead of depending upon descriptions or drawings; and as the possibility of obtaining these series becomes the better known,

it is quite likely that all the resources of the Commission for making collections, great as they are, will be fully taxed.

The calls for these specimens are usually made through the member of Congress representing the district in which the institution is established; or if made directly to the Commission, they are referred to the member for his indorsement and recommendation.

Some noteworthy features of the year 1883 were as follows:

1. The completion of the Albatross and her arrival in Washington, March 24, fully equipped for service.

2. The use of the Albatross in studying the movements of schools of menhaden, mackerel, and other ocean fishes.

3. The use of the electric light by the Albatross in submarine explorations.

4. A request from prominent men of Great Britain connected with the International Fisheries Exhibition for an exhibit of the Albatross.

5. The loan of the Albatross, in compliance with a request of the Navy Department, for a cruise in the Caribbean Sea, the arrrangements for which were completed during the year, although the cruise did not commence until January 4, 1884.

6. The employment of the Fish Hawk in hatching Spanish mackerel in the Chesapeake Bay.

7. The stranding of the Fish Hawk on Ocean Beach on the night of July 13, and her recovery, without serious damage, on July 18.

8. The transfer of land at Wood's Holl, on April 20, from trustees (representing the subscribers who furnished the purchase-money) to the United States, and the beginnings of the erection of building thereon.

9. The commencement and vigorous prosecution of work on the pier and breakwater at Wood's Holl, for which money was appropriated by Congress the preceding year.

10. The opening of the Great International Exhibition at London, May 1, and its closing on October 31, during which time a large exhibit was made by the U. S. Fish Commission, which attracted universal attention.

11. The continuance of the investigation of the ocean fisheries by a special committee of the United States Senate (Hon. E. G. Lapham, chairman), with the co-operation of the U. S. Commission, represented by Mr. Marshall McDonald, and including the use of the Fish Commission steamer Lookout.

12. The perfecting of an arrangement with the Life-Saving and Light-House Services whereby the keepers for the entire coast make telegraphic reports to the Commission of the stranded whales, porpoises, and other forms of marine life.

13. The hearty co-operation of certain railroad corporations in the work of distributing shad, carp, whitefish, &c., by transporting the Fish Commission cars free of charge. Notably among these were the Northern Pacific, which moved a car loaded with carp from Saint Paul to Portland, Oreg.; the Missouri Pacific, and the Atchison, Topeka and

Santa Fé, which carried a car from Saint Louis through Arkansas and Texas and back; the Flint and Père Marquette, which furnished many free trips for the cars containing whitefish; the Utah Central and various other companies.

14. The selection of a plan for a suitable fishway to be erected at the Great Falls of the Potomac, and the accomplishment of the preliminary surveys therefor.

15. The laying out of extensive experimental oyster-ponds at Saint Jerome Creek, Md.

16. The success of Mr. John A. Ryder in the artificial propagation of oysters at Stockton, Md.

17. The completion of an apron and other improvements at the Havre de Grace station.

18. The opening of the Cold Spring Harbor station by the New York State commission, and its use by the U. S. Commission.

19. The survey of the Columbia River and certain tributaries by Mr. Livingston Stone, with the view to finding suitable localities for salmon hatcheries.

20. The suspension of work at the McCloud River salmon station, the run of salmon having been seriously intermitted by the blasting necessary to the erection of the Northern Pacific Railroad along the river.

21. The increased production of whitefish at Northville and Alpena, Mich., fully 100,000,000 eggs having been taken.

22. The introduction of whitefish into Eagle Lake, Mount Desert Island, Maine.

23. The concerted action of the State fish commissions directly interested in the fisheries of the Great Lakes and the protection of those fisheries.

24. The occupation of Fort Washington, on the Potomac, for shad-hatching, permission having been granted by the Secretary of War.

25. The application of the method of transferring eggs of the shad to a distance, in a moist condition, on trays, it having heretofore been necessary to hatch the eggs at the stations and make the transfer of live fish to a distance.

26. Large run of shad in the Sacramento River, California, resulting from the introduction of young in these waters a few years since by the Fish Commission.

27. The great increase in productiveness of the inshore cod-fisheries, due to the general use of cod gill-nets which were introduced by the U. S. Commission.

28. The reappearance in Gloucester Harbor and at some other points of young cod, believed to belong to a school hatched at Gloucester in 1878.

29. Efforts to hatch cod in New York from eggs taken at Fulton Market.

30. The continued activity in the work of propagation and distribution of German carp.

31. The successful importation from Germany of the blue carp.

32. The discoveries by a Fish Commission agent, Mr. James G. Swan, in regard to the possibilities of an extended fishery on the Pacific coast for the black cod, and its indorsement by New York and Boston experts as a valuable food-fish.

33. The experiments of Mr. S. G. Worth in taking and hatching eggs of striped bass, or rockfish, which give promise of very valuable results hereafter.

A brief memorandum of what the U. S. Fish Commission hopes to accomplish in time, in connection with its mission, is as follows:

1. In the department of investigation and research there is yet to be carried out an exhaustive inquiry into the character, abundance, geographical distribution, and economical qualities of the inhabitants of the waters, both fresh and salt. The subject is practically unlimited in extent, and, so far as the ocean is concerned, has scarcely been touched. With the powerful apparatus, however, at the command of the Commission it is expected that much progress will be made year by year, and that the publication of the results and the distribution of duplicate specimens to colleges and academies in the United States will be carried out on a large scale, so as to meet a large and increasing demand from teachers and students.

2. A second object, in connection with the sea fisheries, is the improvement of the old methods and apparatus of fishing and the introduction of new ones.

The work of the Commission in bringing to the notice of American fishermen the importance of gill-nets with glass-ball floats for the capture of codfish has already revolutionized the winter cod-fishery industry in New England. Looked upon almost with ridicule by the Gloucester fishermen, when first brought to their notice by the Commission, these nets have come rapidly into use, until at the present time they represent the most important element in the winter fisheries, the number of fish taken being not only much greater than heretofore but the fish themselves of finer quality.

The ability to maintain a successful fishery without the use of bait is of the utmost importance, in view of the fact that when cod are most abundant bait is almost unprocurable. Other forms of apparatus of less importance have also been introduced, and a constant lookout is maintained, by correspondence and otherwise, in connection with the improvement of fishing machinery.

3. Another important point for consideration is that of improvement in the pattern of fishing vessels. There is annually a terrible mortality in the fishing crews of New England, especially those belonging to the port of Gloucester, to say nothing of the total loss and wreck of the fishing vessels and their contents. There has gradually developed in connection with the mackerel and cod fisheries of New England a pattern of vessel which, while admirable for speed and beauty of lines

and of rig, is less safe under certain emergencies than the more substantial and deeper vessel used abroad, especially in England and Scotland.

The subject of the best form of fishing-vessel has been intrusted to Captain Collins, of the Commission, himself a most experienced fisherman, and, after a careful study of the boats of all nations, he has prepared a model which is believed to combine the excellencies of both English and American vessels.

An appropriation will be asked from Congress for means to construct an experimental vessel and test its qualities; but until a successful experiment has been made it will be difficult to induce the fishermen to change their present form of construction.

4. The fourth object of the Commission is to determine the extent and general character of the old fishing localities and to discover new ones. There is no doubt whatever that there still remain many important areas, even in the best-known seas, where the codfish and halibut will be found in their former abundance. There has never been any formal investigation on this subject, and the banks that are known have been brought to light purely by accident. It is believed that by a systematic research and a careful survey the area of known grounds can be greatly extended.

There is very great reason to hope for successful results from this inquiry in the waters off the South Atlantic coast and in the Gulf of Mexico. These regions, the latter especially, may be considered as practically unknown, the few established localities for good fishing being in very small proportion to what must exist. It is here that the service of the fishing schooner referred to above, if means can be obtained to build it, will be brought into play, and it is not too much to hope that an industry will be developed that will represent to the Southern aud Southwestern States the same source of income and occupation that the mackerel, cod, and halibut furnish to the fishermen of New England.

5. There is also much to be learned in the way of curing and packing fish for general and special markets. The American methods have grown up as a matter of routine, and are adapted to only one class of demand. There are, however, many modes of preparation which can be made use of to meet the wants of new markets; and thus we can enter more efficiently into competition with European nations for European trade, as well as for that of the West Indies and South America.

A great advance has already been made toward this desired improvement since the Centennial Exhibition of 1876, where many methods of curing and putting up fish were shown in the foreign sections that were almost entirely unknown in America. Notable among these were the preparations of sardines and other species of herring in oil, as well as in spiced juices. Quite recently this industry has been well established in Maine, amounting to a value of millions of dollars, and there are many other parts of the country where the same work can be done with other kinds of fish. The whole subject is receiving the careful consideration of the Commission, and numerous facts bearing upon it have been announced in its reports and bulletins.

6. The work of increasing the supply of valuable fishes and other aquatic forms in the waters of the United States, whether by artificial propagation or by transplantation, although very successful, may be considered as yet in its infancy.

It must be remembered that the agencies which have tended to diminish the abundance of the fish have been at work for many years and are increasing in an enormous ratio. This, taken in connection with the rapid multiplication of the population of the United States, makes the work an extremely difficult one. If the general conditions remained the same as they were fifty years ago, it would be a very simple thing to restore the former equilibrium.

At that time, it must be remembered, the methods of preservation and of wholesale transfer, by means of ice, were not known, while the means of quick transportation were very limited. Hence a small number of fish supplied fully the demand, with the exception, of course, of species that were salted down, like the cod, the mackerel, and the herring (including the shad). Now, however, the conditions are entirely changed. The whole country participates in the benefits of a large capture of fish, and there is no danger of glutting the market, since any surplus can be immediately frozen and shipped to a distance or held until the occurrence of a renewed demand.

Another impediment to the rapid accomplishment of the desired result is the absence of concurrent protective legislation of a sufficiently stringent character to prevent unnecessary waste of the fish during the critical period of spawning, and the erection or maintenance of impediments to their movements in reaching the spawning grounds. This is especially the case with the shad and the salmon, where the simple construction of an impassable dam, or the erection of a factory discharging its poisonous waste into the water, may in a few years entirely exterminate a successful and valuable fishery.

It is to be hoped that public opinion will be gradually led up to the necessity of action of the kind referred to, and that year by year a continued increase in the fisheries will be manifested. Even if this does not occur as rapidily as some may hope, the experiments so far furnish the strongest arguments in favor of continuing the work for a reasonable time. A diminution that has been going on for fifty or more years is not to be overcome in ten, in view of the increasing obstacles already referred to.

Among the species, an increase of which in their appropriate places and seasons is to be hoped for, in addition to those now occupying the attention of fish-culturists, are the cod, the halibut, the common mackerel, the Spanish mackerel, the striped bass, or rockfish, &c.

One of the most important, and at the same time among the most promising, fish is the California trout, with which it is hoped to stock large areas of the country. Its special commendations will be found mentioned elsewhere.

Another fishery earnestly calling for assistance, and capable of re-

ceiving it, is that of the lobster, the decrease of which has been very marked. The experiments of the Fish Commission suggest methods by which the number can be greatly increased. Something, too, may be done with the common crab of the Atlantic coast and its transfer to the Pacific. Some kinds might also be advantageously brought to the eastern portion of the United States from the Pacific coast and from the European seas.

A subject of as much importance as any other that now occupies the attention of the Fish Commission is an increase in the supply of oysters. In no department of the American fisheries has there been so rapid and alarming a decrease, and the boasted abundance of this mollusk on the Atlantic coast, especially in Chesapeake Bay, is rapidly being changed to a condition of scarcity which threatens practical extermination, as is almost the case in England. A fishing industry producing millions of dollars is menaced with extinction, and needs the most stringent measures for its protection.

The U. S. Fish Commission has been very fortunate, through its agents and assistants, in making important discoveries in connection with the propagation of the oyster, which are to be referred to hereafter; and it is proposed to establish several experimental stations for applying the discoveries thus made, so as to constitute a school of instruction and information to persons practically engaged in the business.

There are other shell-fish besides the oyster that will well repay the trouble of transplantation and multiplication. Among these are several species of clams belonging to the Pacific coast of the United States, which are much superior in size, in tenderness, and in excellence of flavor to those on the eastern coast. Most of these are natives of Puget Sound, and the completion of the Northern Pacific Railway is looked forward to as a convenient means of transferring them to Eastern waters. The common clams of the Atlantic coast are also fair subjects of experiment.

As might be expected, the correspondence of the Commission presents the usual increase in magnitude; requiring, of course, increased service in briefing, registering, filing, &c.*

* *Table showing the number of letters received and written and the number of fish applications received by the U. S. Fish Commission during the fiscal year ending June 30, 1883.*

Months.	Letters registered.		Fish applications registered.	Total of letters and applications.
	Received.	Written.		
1882.				
July	696	547	264	1,507
August	397	534	74	1,005
September	325	588	405	1,318
October	1,656	692	1,093	3,441
November	1,557	721	692	2,970
December	1,355	930	1,380	3,665
1883.				
January	1,501	1,121	905	3,527
February	1,514	1,050	774	3,338
March	1,620	1,073	859	3,552
April	1,572	1,046	784	3,402
May	1,102	786	199	2,087
June	1,057	828	505	2,390
Total	14,352	9,916	7,934	32,202

The Commission lost, by the death of Mr. Frank S. Eastman on March 12, an accomplished engineer and draughtsman, to whom it owed very much in connection with the planning and building of its fish-transportation cars.

Although not at the time an employee of the Commission, but as having formerly been in its service, it is proper to mention the death of Mr. O. M. Chase, on November 11. Mr. Chase, at the time of his death, was superintendent of the fish hatchery of the State of Michigan, at Detroit, and was engaged in collecting eggs of whitefish. Mr. Chase and a party of his employees, while crossing a bay in a small boat during a violent storm, were drowned by the upsetting of the boat. He was one of the most experienced fish-culturists of the country, having been trained by Mr. Seth Green, and having been in his employ, and also in that of the Fish Commission, before entering the service in which he met his death.

The three-story building No. 1443 Massachusetts avenue, which was leased in 1881, has continued to be occupied as an office by the Commission. The commissioner has, however, continued to use for himself and stenographer certain rooms in his private residence.

2.—PRINCIPAL STATIONS OF THE U. S. FISH COMMISSION.

These stations have been mentioned in previous reports, and a full explanation given of their general character. There are therefore simply enumerated in the present report to serve as a convenient table of reference. The special work accomplished at each station for the year will be given hereafter.

A.—Investigation and Research.

1. *Gloucester, Mass.*—Capt. S. J. Martin, in charge of this station, continues his weekly reports of the products of the off-shore fisheries of that city, which have been collated and published from time to time in the Bulletins of the Fish Commission.

Captain Martin visits every vessel on its arrival and obtains the statistics of the catch during the voyage; and as there is no other organization for obtaining these data, his figures are largely used in the market reports of the Boston and Gloucester papers.

2. *Wood's Holl, Mass.*—This continues to be the headquarters of the Commission during the summer, and the chief locality for investigation and research. It is also the summer station of the vessels of the Commission.

The arrangements made for enlarging the work at this point will be more fully detailed hereafter.

3. *Saint Jerome, Md.*—This station is maintained for experiments in oyster culture and the hatching of marine fish, especially of the Spanish mackerel.

B.—PROPAGATION OF SALMONIDÆ.

4. *Grand Lake Stream, Me.*—The propagation of the landlocked or Schoodic salmon is carried on here on a large scale, under the direction of Mr. Charles G. Atkins.

5. *Bucksport, Me.*—The work of this station, also in charge of Mr. Atkins, is primarily connected with the multiplication of Penobscot salmon.

6. *Northville, Mich.*—This establishment is principally concerned in the hatching of whitefish, which are collected by Mr. F. W. Clark and his assistants, and at the proper time are either forwarded, in the condition of embryonization, to distant points, or entirely hatched out and the minnows transmitted to suitable localities. The station is also used for breeding the Eastern brook-trout and the California trout, of which a good stock is maintained. Two new trout ponds were completed in June.

7. *Alpena, Mich.*—This station was established in 1882 for the whitefish service, as being conveniently near the best localities for taking the eggs. It is kept as a feeder to the Northville station, which is the main one.

8. *Baird, Shasta County, California*—This station, on the McCloud River, is devoted exclusively to the cultivation of the California salmon, for which it is eminently adapted.

9. *Trout ponds near Baird, Shasta County, California.*—This locality, situated about 5 miles from the salmon station, is devoted to keeping up a large stock of California trout to supply eggs for eastern waters. The wild character of the region may be readily understood from the fact that the trout are fed on the meat of the black-tailed deer, as being the cheapest food that can be supplied to them.

10. *Wytheville, Va.*—In view of the expense attendant upon the transporting of the young Salmonidæ, such as California trout, brook-trout, landlocked salmon, &c., from Northville, Mich., and other stations, to distant points, especially the southern Alleghanies, it was concluded best to establish a station for hatching the same somewhere in the mountains of Virginia, as giving convenient access to the principal States having a water-supply fitted for the growth of such species. The Virginia fish commissioner had several years ago selected a locality near Wytheville, Va., as the most eligible spot known to him, and where an almost inexhaustible volume of cold spring water of the utmost purity was procurable. An arrangement was accordingly made to rent this station for the purpose in question, at a reasonable price; and a large number of eggs were sent there in the autumn of 1883, and successfully hatched out.

11. *Cold Spring Harbor, N. Y.*—For the purpose of hatching eggs of the salmon and of the whitefish for introduction into the rivers and lakes of Northern Pennsylvania, New York, and other adjacent States, arrangements were made to occupy, in part at least, the station of the

New York fish commission at Cold Spring Harbor, Long Island. This place is in convenient proximity to New York, and consequently enjoys excellent facilities for transportation and distribution. It is in charge of Mr. Fred Mather, who carries on simultaneously work for the State of New York and for the United States. Large numbers of salmon and other species have been successfully hatched out at this station and distributed to New York, Connecticut, and Pennsylvania.

Experiments will be made during the winter in the propagation of cod and tomcod at the Cold Spring Harbor station.

C.—Propagation of Shad.

12. *Havre de Grace, Md.*—The work connected with the propagation of shad in their breeding grounds in the Susquehanna River, previously carried on by barges anchored in Spesutie Narrows, has been transferred to an artificial island known as Battery Island, which is a few miles below the railroad bridge at Havre de Grace. The facilities already established at this station were extended during the year, with the expectation of their yielding large results.

13. *Central Station, Washington, D. C.*—This station, established in the old Armory building, now constitutes an important point for hatching shad, herring, salmon, whitefish, and several other fish, and for their distribution by cars to distant parts of the country.

14. *Fort Washington, Md.*—This point was occupied this year for the first time, by permission of the War Department, and placed in charge of Lieut. W. C. Babcock, U. S. N.

D.—Propagation of Carp.

15. *Monument Reservation, Washington.*—This is the principal station for the production of carp. The varieties cultivated are the leather and mirror carp. Goldfish (*Cyprinus auratus*), golden ides, and tench are also raised in considerable numbers.

16. *Washington Arsenal grounds.*—Cultivation at this station is confined to the scale carp.

Fuller details in regard to the work and results of all these stations will be found under the head of the specific work for which they are maintained.

3.—NEW HATCHING STATIONS ASKED FOR.

1. *On the Columbia River.*—On January 18, 1883, Hon. J. H. Slater, United States Senator from Oregon, transmitted the following communication from the Astoria Chamber of Commerce, asking for the establishment of a salmon hatchery on the Columbia River or on one of its tributaries:

ASTORIA, OREG., *December* 29, 1882.

DEAR SIR: The Astoria Chamber of Commerce would respectfully ask for the establishment of a salmon hatchery by the General Government on the Columbia River or its tributaries.

It is expected that the railroad will be connected with the river, forming a continuous, uninterrupted line across the continent, before the month of August, 1883, and in time to distribute any spawn taken in that year.

The Columbia River salmon for distribution would be unequaled, while the restocking of the parent waters would be of great value.

The catch on the Columbia in 1882 was not less than 1,600,000 fish, and surely so great an industry and consumption needs fostering.

We exported from the Columbia River, in 1882, 540,000 cases, valued at $2,900,000.

There are twenty-four salmon canneries now at Astoria and ten more within 30 miles, representing a permanently invested capital, in ground, buildings, machinery, &c., of at least $850,000.

No other river in the United States produces so fine a quality of salmon (the Quinnat); it is preferred in every market of the world, has more oil and a finer color and flavor, and commands an average of 15 per cent in price over the product of any other river.

Respectfully submitted by order of the Astoria Chamber of Commerce.

E. C. HOLDEN, *Secretary.*

Hon. SPENCER F. BAIRD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.

Subsequently Hon. M. C. George wrote requesting the Commission to do anything in its power to further the proposition. Accordingly Mr. Livingston Stone was directed to make a careful exploration of the river and its tributaries during the summer. His report and recommendations will be found in the appendix to this volume.

2. *At Milwaukee, Wis.*—On the 15th of January, 1883, a communication was received from Philo Dunning, president of the Wisconsin fish commission, transmitting a copy of some resolutions which had been adopted by the Wisconsin commission, and also a copy of a joint resolution of the State legislature of Wisconsin. On the 5th of February, Hon. R. D. Torrey, general manager of the Milwaukee Industrial Exposition Association, transmitted a resolution passed by the directors of the association making a similar request.

The common council of Milwaukee also passed a resolution of approval of the project.

The Fish Commission was unable to comply with these requests, as it had not the means for establishing additional hatcheries, and as those at Northville and Alpena furnished facilities for taking care of all the eggs obtainable in that region.

The resolutions and memorials referred to above were as follows:

At a regular meeting of the Wisconsin fish commission held on the 7th of January, 1883, the following action was taken with reference to the location of the Northwestern branch of the United States fish hatchery in Milwaukee:

Whereas we believe in the industry of the artificial propagation of the better classes of native and foreign fish, and recognize with satisfaction the efforts the General Government, under the efficient management of Prof. Spencer F. Baird, U. S. Commissioner of Fish, is putting forth in this direction; and

Whereas we believe no better place can be found than is offered in the city of Milwaukee, Wis., for the location of the Northwestern branch of the Government hatchery: Therefore,

Resolved, That we cordially invite Professor Baird to examine the facilities offered in this city, at an early day, with reference to locating said branch in this place.

Resolved, That a copy of this action be sent to Hon. P. V. Deuster, M. C., with the request that he present the same to Professor Baird and use his influence in carrying out the purpose thereof.

PHILO DUNNING,
President.
C. L. VALENTINE,
Secretary.

MILWAUKEE, *January* 7, 1883.

Resolved, That we, the board of directors of the Milwaukee Industrial Exposition, fully indorse the action of the Wisconsin State fish commission in their efforts to secure the location of the Northwestern branch of the Government fish hatchery in this city, and cordially invite Prof. Spencer F. Baird, U. S. Fish Commissioner, to visit Milwaukee and examine the conveniences offered in the exposition building for such purpose.

MILWAUKEE, *January* 8, 1883.

Extract of the action taken by the board of directors of the Milwaukee Industrial Exposition Association.

R. D. TORREY,
General Manager.

Joint resolution No. 1, S., inviting Spencer F. Baird to visit the State with a view to the establishment of a fish hatchery, &c.

Resolved by the senate (the assembly concurring), That Spencer F. Baird, U. S. Fish Commissioner, of the U. S. Commission of Fish and Fisheries, be, and he is hereby respectfully invited to visit Wisconsin, either personally or through an agent to be designated by him for that purpose, with the view to the establishment within this State of a United States fishery and hatching house for fish, at some suitable place to be approved by him; and that a duly certified copy of this resolution, attested by the chief clerks of the senate and assembly, be forthwith transmitted to said Spencer F. Baird, at the city of Washington, in the District of Columbia.

CHARLES E. BROSS,
Chief Clerk of the Senate.
I. T. CARR,
Chief Clerk of the Assembly.

4.—VESSELS OF THE U. S. FISH COMMISSION.

A.—THE STEAMER ALBATROSS.

The first year's work of this steamer has been very important and has fully met all reasonable expectations. During all of January and until the 10th of February she was at the Washington navy-yard, receiving apparatus and being put in condition for a cruise. It was found necessary, however, to return her to the shops of Pusey & Jones, at Wilmington, to make some alterations in the engines, which having been completed, the vessel started again for Washington on the 21st of March, arriving on the 25th. On the way several soundings and dredgings were made in from 82 to 641 fathoms. The vessel arrived at Washington March 25, the sounding and dredging apparatus having worked satisfactorily in these experimental tests, with the exception of the submarine electric light. On the 24th of April the vessel went to sea, under orders to investigate the conditions which govern the movements of the mack-

erel, menhaden, bluefish, and other migratory species, beginning off Hatteras and following up the schools in their movements. The physical conditions of the surroundings as to temperature and currents, as well as the chemical and biological peculiarities of the water, were also to be examined. The commander was directed to communicate with fishing vessels, in order to obtain information from them in regard to the movements of fish and their success in fishing. The dredging and trawling operations were to be carried on as frequently as opportunity offered. To what extent these purposes were attained may be seen by examination of the report of Lieutenant-Commander Tanner, U. S. N., in the appendix.

On the 31st of May the vessel went into the dry-dock at the Brooklyn navy-yard, where the magnetic survey of the vessel, which had been begun in April, was completed by Lieutenants Wainwright and Diehl, U. S. N., under direction of the Navy Department. She left New York on the 8th and arrived at Washington on the 19th of June. Preparations were then made for the summer cruise, which was commenced July 6, under orders quite similar to those of the previous trip. Capt. Jacob Almy, of New Bedford, accompanied the ship as a fisherman expert. During this cruise a large number of reports relating to the mackerel and menhaden fisheries were obtained from fishing vessels and factories, which will be found in Captain Tanner's report in the appendix. The Albatross ran into Wood's Holl on July 14, and left two days later, with a number of naturalists on board, for a dredging trip along the edge of the Gulf Stream. July 20th she went to Newport for coal, and returned to Wood's Holl on the 24th. From July 25 to August 1 was spent in dredging trips, during which many successful hauls were made. On the 6th of August the investigation of the menhaden and mackerel fisheries was resumed. The vessel proceeded by way of Newport to Block Island, No Man's Land, and the coast of Long Island. But very few fish were seen on this trip. She returned August 10, and on the 20th started out again in search of mackerel in the region about Nantucket, George's Banks, Cape Sable, Grand Manan, &c., returning to Wood's Holl September 6. During the various trips many fishing vessels were met with, and valuable statements obtained from them by Captain Almy, the substance of which is given in Captain Tanner's report.

Having taken coal at New Bedford, and made necessary repairs, the Albatross again started off on the 19th of September, for the purpose of making another examination of the tilefish grounds. The party returned on the 22d, having taken one swordfish and several kinds of smaller fish, but no tilefish. Between September 29 and October 5 a successful dredging trip was made to the Gulf Stream. Having coaled at Newport on the 12th of October, Captain Collins was taken on board as expert fisherman in place of Captain Almy, whose term of service had expired, and another cruise was then made for the pur-

pose of investigating the migrations of mackerel and menhaden. The vessel proceeded to Block Island, Barnstable Bay, Boston Bay, Gloucester Harbor, and returned southward by Stellwagen Bank, No Man's Land, and Sandy Hook. A call was made at the Brooklyn navy-yard to obtain coal and provisions. The vessel then cruised southward as far as Cape Hatteras, and entering the Chesapeake, arrived at Washington November 13. From this time until the end of the year the vessel was at the navy-yard refitting for a winter cruise. In the reports of Capt. J. W. Collins, Capt. Jacob Almy, Mr. James E. Benedict, Ensign R. H. Miner, U. S. N., Surgeon C. G. Herndon, U. S. N., Engineer G. W. Baird, U. S. N., and Lieut. Seaton Schroeder, U. S. N., all of which are embodied in the report of the commander and contained in the appendix, will be found the details of the several cruises and an epitome of the work accomplished.

The *personnel* of the steamer during the year consisted of —

Lieut.-Commander Z. L. Tanner, U. S. N., commanding officer.

Lieut. Seaton Schroeder, U. S. N., executive officer and navigator, in charge of hydrography and meteorology.

Lieut. Sidney H. May, U. S. N., watch officer, in charge of sounding apparatus.

Lieut. A. C. Baker, U. S. N., watch officer, in charge of dredging apparatus.

Ensign Clifford J. Boush, U. S. N., watch officer, in charge of electric apparatus.

Ensign R. H. Miner, U. S. N., recording officer, in charge of marine vertebrates.

Surgeon Jerome H. Kidder, U. S. N., medical officer, in charge of chemistry.

Paymaster George H. Read, U. S. N., pay officer, in charge of photography.

Passed Assistant Engineer George W. Baird, U. S. N., chief engineer, in charge of special mechanical appliances.

James E. Benedict, resident naturalist.

By direction of the Secretary of the Treasury, the collector of customs at Wilmington, Del., reported as follows in regard to the measurements of the Albatross:

Register length ....feet..	205.00
Register breadth ....feet..	27.50
Register depth ....feet..	16.50
Measurement ....tons..	385.88
Gross tonnage ....tons..	638.82

This may be a suitable place to mention the fact that a model of the Albatross, furnished by Pusey & Jones, excited much interest at the London Exhibition, and a great desire was expressed to have the vessel herself sent there, in order that her many special and interesting peculiarities might be examined. It was, however, not considered expedient

to withdraw the vessel from her field of duty, as the extra expense could not be spared from the London Exhibition appropriation; neither could the cost of coal and other necessary expenses that would have been involved, be paid by the Fish Commission.

The Navy Department, through Commodore Walker, chief of the Bureau of Navigation, made application for the services of the Albatross in connection with the taking of soundings and other investigations in the Caribbean Sea, with the understanding that the expense of maintenance and repair of the vessel during the period of its transfer was to be assumed by the Navy Department. This was assented to, and preparations were duly made towards the end of the year. As, however, the cruise itself was made in the subsequent year, the report of 1884 will contain the details.

In a special report by Captain Tanner upon the construction of the Albatross and her operations for the year will be found many details of great scientific and practical interest. A full account is also given of the system of electric lighting, by Engineer G. W. Baird.

B.—The Steamer Fish Hawk.

This vessel remained during the entire year under the command of Lieut. William M. Wood, U. S. N. She was at the Washington navy-yard until March 15, when a trip was made to the Chesapeake, in search of the sperm whale reported ashore at Smith's Point, Virginia. The whale was not found, but the fisheries at Marlborough and Brent's Points were examined. A few shad and herring and quite a number of rock, perch, &c., were being taken.

On the 24th of March the Fish Hawk again left Washington, with a lot of material for Havre de Grace station. The vessel reached that point the next day, having called at the Saint Jerome station on her way. After coaling at Baltimore she proceeded to Saint Jerome and dredged for oysters a few hours. On the morning of the 1st of April she returned to the Washington navy-yard. On the 12th of April Lieutenant Wood sailed for Shipping Point, on the Potomac, with orders to commence the hatching of shad, herring, and rockfish, collecting eggs in that region of the river south of Gunston's Cove. The fisheries were found to be in successful operation, but it was some days before the fish were ripe enough to furnish suitable eggs for propagation. During the first ten days the temperature was very low, and over 7,000,000 herring eggs were lost by sudden changes of temperature. On the 7th of May the vessel was moved to Glymont, where the water was found to be both clearer and warmer. Nine hundred thousand herring and 60,000 perch eggs were taken the first day. The taking and hatching of eggs was continued at this point until about the 25th of May, when the vessel returned to Washington.

She was then ordered to prepare to sail June 4 for the mouth of the Chesapeake, and on the way to locate upon charts the pound-nets and

to report their season's work, names of owners, amount of fish taken, &c., both on the Potomac and in the Chesapeake. Lieutenant Wood was further directed to examine various points with a view to propagating Spanish mackerel and the oyster. The vessel arrived at Fairport, Va., on this mission June 6, and at Cherrystone, Va., June 12, which terminated this part of the investigation. An abstract of the information obtained concerning the pound-nets in the Potomac will be found in the Fish Commission Bulletin for 1883, pages 278–280. A call was made at Hampton upon Professor Brooks, who was found at his laboratory experimenting upon oysters.

The vessel arrived at York Spit June 18, and commenced prospecting for Spanish mackerel. On the 21st the first ripe spawn was obtained, and the vessel was continuously engaged in this work until the 3d of August. An account of the work and of some new apparatus which was employed will be found in two papers in the appendix, one by Lieutenant Wood and the other by Dr. J. Alban Kite.

On the 13th of July the vessel was anchored off Ocean Beach, near Hampton Roads. That evening a sudden heavy storm caused the vessel to drag her anchor and blew her ashore. Assistance was obtained on the 14th from the Baker Wrecking Company, of Norfolk, and at different times from the Army tug Monroe, the U. S. S. Pinta, the tug Snowdrop, the revenue-cutter Ewing, and the lighthouse tender Holly. At 5 a. m. on the morning of July 18 the ship was floated. Fortunately it was found that but little injury had been done.

On the 5th of August the vessel was coaled in Baltimore, and on the 13th an unsuccessful attempt was made to get some more Spanish mackerel eggs. After being delayed at Hampton by bad weather until the 17th Lieutenant Wood proceeded, by way of Sandy Hook and Hell Gate, to Wood's Holl, where he arrived on the evening of August 20. On the 22d the vessel sailed for a trawling trip to the edge of the Gulf Stream. Several stations were made, and the vessel returned to Wood's Holl on August 24.

The Decatur H. Miller, of the Merchants and Miners' Transportation Line, being reported ashore in Vineyard Sound September 23, Lieutenant Wood immediately went to her assistance, finding already there the Coast Survey steamer Blake and the revenue steamer Dexter. By their joint action the vessel was floated the same evening. The services of the Fish Hawk in connection with the relief of the Decatur H. Miller were formally acknowledged by the secretary of the company.

The Fish Hawk remained with headquarters at Wood's Holl until October 16, when she took on board certain freight for Washington. Having called at Newport to coal and at New York for provisions and stores and 100 live lobsters to be deposited in Chesapeake Bay, she arrived at the capes October 27 and at Washington on the 30th. An account of the transfer and successful plant of the lobsters near Fort Wool will be found in the Bulletin for 1884, page 16.

The next work assigned to the Fish Hawk was that of laying out oyster-ponds at Saint Jerome station, for which purpose she left Washington November 12, and arrived at Saint Jerome the next day. An account of the dredging and of the laying out of three oyster-ponds will be found in the appendix to this report. The vessel returned to Washington November 26, where she remained until the close of the year.

A renewed measurement of the tonnage of the Fish Hawk was made under order of the Treasury Department, the figures being 441.40 tons gross measurement and 205.1 tons net measurement; signal letters G. V. Q. C.

The officers during the year were as follows:

Lieut. W. M. Wood, U. S. N., commanding officer.

James A. Smith, mate and executive officer.

D. H. Cleaveland, mate.

William L. Bailie, passed assistant engineer, acting chief engineer.

J. Alban Kite, M. D., civilian, apothecary.

C.—The Lookout.

The steamer Lookout, belonging to Mr. T. B. Ferguson, and used by the Fish Commission since 1878 without any compensation to the owner, has continued to render excellent service in the operations of the Commission, partly in transporting supplies between Washington and the stations at Saint Jerome and Havre de Grace, and partly in close relationship with the propagation of shad, Spanish mackerel, and oysters.

As stated in the previous report, Lieutenant Wood having been transferred to the command of the Fish Hawk on the 20th of November, 1882, the command of the Lookout devolved upon Chief Quartermaster William Hamlen, whose long service with the Fish Commission and zealous performance of his duties warranted his being continued in this responsible position during the year, especially as on so small a vessel proper accommodations for a naval officer of rank could not be provided.

Soon after the change in the command of this steamer she was transferred from the head of the Chesapeake Bay to the Washington navy-yard, and Mr. Hamlen was detached temporarily to conduct some experiments in hatching codfish at Fulton Market, New York City.

Towards the end of February, the vessel having been equipped for a southern cruise, Lieut. Francis Winslow was instructed to make some investigations as to the oyster-beds of the Potomac River and Chesapeake Bay while the steamer was on the way to Norfolk. On the 3d of March she sailed from Norfolk to Charleston, by the inland route, and arrived at Beaufort, N. C., on the 6th, where she was storm-bound until the latter part of the month.

The collector of customs, by direction of the Secretary of the Treasury, caused her to be measured while she was at Charleston, and re-

ported her gross tonnage 54.49, net tonnage 28.76; and signal letters G. V. Q. D. were assigned her.

On the 19th of that month she was joined at Charleston by Assistant Commissioner T. B. Ferguson, who proceeded to Florida for the purpose of investigating the condition of the shad fisheries on the Southern Atlantic coast, with a view of establishing hatching stations. Extracts from Mr. Ferguson's report on this inspection will be found on page 244 of the fourth volume of the Fish Commission Bulletin (1884). The Lookout returned to Charleston on the 2d of April, the investigations in the more southern waters having been hurriedly made on account of being due at Washington to report for work on the Potomac and Susquehanna Rivers.

She arrived in Washington on the 19th, but having been run into by a schooner in the narrow channel near the navy-yard, she was sent to Baltimore for repairs, which were completed by the 2d of May. She was immediately transferred to the Potomac River, where she materially aided in the prosecution of the shad-hatching operations in that locality.

During the month of June she was employed as a dispatch boat in making inspections of the Saint Jerome and Battery stations; but, unfortunately, on the 30th of the month, while proceeding down the Potomac, her shaft broke. This accident deprived the Commission of her services until the necessary repairs could be made. Secretary Chandler having given instructions for the repairs to be promptly made at the Washington navy-yard, they were completed by the 11th of July, and on the following day she sailed for the Lower Chesapeake, and was employed during the rest of the month in hatching the Spanish mackerel and investigating the oyster-beds in that region.

In September she was utilized for transferring flumes, to be used in the oyster-ponds, from Saint Jerome station to Norfolk, to be treated with preservatives.

This service was intermitted by the transfer of the vessel for a time to the subcommittee of the Senate Committee on Foreign Relations, Senator Lapham, chairman, which was engaged in making inquiries into the condition of the menhaden fisheries of the Chesapeake. On the completion of this work she resumed the transfer of the lumber between Saint Jerome and Norfolk, and then returned to Washington.

After a short stay she was again employed in connection with the Saint Jerome station during November.

At the close of the year the Lookout was laid up at the Washington navy-yard to undergo repairs and some alterations for the purpose of better adapting her to the varied services which she might be called upon to perform.

D.—Launches.

The only launch actually belonging to the miscellaneous service of the Commission, Herreshoff, No. 82, was in constant service during the

year. In the spring she served as a tender to the work of fish propagation at Battery Station, and in the summer she was used in connection with the marine investigations at Wood's Holl. By reason of her general seaworthiness, she was able to proceed without convoy to the New England coast, and to return without any damage.

The other launches, belonging to the Navy Department, were also in constant use and kept in thorough repair by the Commission.

E.—The Canvas-Back.

In a previous report reference was made to a small light-draft steamer, which it was considered desirable to have for service in laying out the seine over the shoal waters at Battery Station. Although such a vessel would have been very desirable, no appropriation was available for its construction, and the project remains in the same condition as last year.

F.—Proposed Fishing Schooner.

Reference has been made in previous reports to the project of having a schooner constructed with a well, in which living fish might be transported from place to place, to be used more especially as a tender to the Wood's Holl station in bringing in living codfish, halibut, and other species from distant points, to be kept in basins until the eggs were ripe for removal. Such an appendage is deemed absolutely necessary to the proper working of the Wood's Holl establishment.

Capt. J. W. Collins, one of the assistants of the Fish Commission, and who for many years has been a highly successful practical fisherman of Gloucester, was directed to prepare a model, drawings, and specifications of a suitable vessel that should contain, as far as possible, all the best qualities of the fishing service of both America and Europe, and serve as a suitable mean between the comparatively shoal schooners used in the United States and the deeper draft of the European smack. Well fitted by his previous experience, he utilized his attendance upon the Berlin Fishery Exposition in 1880, and that of London in 1883, to solve the problem submitted to him; and a model which the U. S. Fish Commission exhibited at London was highly approved by those who were competent to criticise and judge. It is hoped that Congress may at an early date furnish the means for building such a vessel, and not only aid the Commission in carrying out its work, but also in supplying a pattern for imitation by the fishermen.

Very few persons realize the annual loss of property and life incurred in connection with the fishing fleet of New England, especially off George's Banks, which are not improperly called "Gloucester's graveyard." There has been for many years an average destruction of 10 vessels and the loss of 100 lives; sometimes the figures are considerably larger. These vessels, for the most part, founder and disappear entirely, without leaving any trace behind or any suggestion as to the actual causes of their destruction.

5.—FISH HATCHING AND TRANSPORTATION CARS.

Reference has been made in previous reports to the important service rendered the Commission by its two cars.

Of these, No. 1 consisted of a first-class baggage car formerly belonging to the Philadelphia, Wilmington, and Baltimore Railroad Company, fitted up for the required service. It is 51 feet 2 inches long, without platform; with platform, 57 feet 6 inches; total height from the track to the topmost projection, 14 feet 1½ inches; total width, 9 feet 10 inches.

The experience gained by using this car was subsequently utilized in the construction of a second car for the Commission by the Baltimore and Ohio Railroad Company, and which contained many important improvements upon the work of car No. 1.

The dimensions of car No. 2 are 59 feet 9 inches in length between the outer ends of the buffers; height, 14 feet ⅞ inch from the top of track to top of hood; width, 10 feet.

The efficiency of these cars and the service rendered by them in the work of the Commission, both in the transportation of young fish and in the hatching of eggs, render a third very desirable. Plans for this have been prepared, and will be applied in the event of an appropriation for the same being granted by Congress. Details in regard to the uses made of these cars during the year will be found in the report of the distribution division. It may, however, be interesting to learn that car No. 1 traveled during the year 31,993 miles in the distribution of carp, salmon, and shad. The number of shad distributed was 6,715,000; of herring, 5,550,000; of carp, 113,605; and of salmon, 450,000.

6.—COURTESIES EXTENDED TO THE U. S. FISH COMMISSION.

A.—BY THE GOVERNMENT.

As in previous years, I have the pleasure of acknowledging many important courtesies extended to the Commission by the various Departments of the Government, by railroad and steamboat companies, and by individuals. Indeed, without the help thus rendered it would be quite impossible to carry on the work on its present scale without a very considerable increase in the appropriations.

TREASURY DEPARTMENT.—*Secretary's Office.*—Mr. Hobbs was authorized by the Secretary of the Treasury on the 8th of August to disburse the appropriation for the Wood's Holl buildings.

Light-House Board.—The Light-House Board, May 28th, authorized the further use of the storage building at Wood's Holl previously occupied by the Commission. Instructions were given to the inspector of the second light-house district to place a mooring for the Albatross in Great Harbor, Wood's Holl, Mass. The Light-House Board has continued to assist in taking ocean temperatures at about thirty-five of the light-houses and light-ships most favorably located.

Coast Survey.—It has been found necessary to call frequently upon the Coast Survey for tide-tables, maps, and charts required for the use of the different vessels of the Fish Commission, which have always been promptly furnished.

Life-Saving Service.—In connection with the propagation of codfish in the vicinity of New York, certain life-saving crews were directed to aid the employees of the Fish Commission.

The arrangement made by the Superintendent of the Life-Saving Service, early in the year, for the telegraphic announcement to the Smithsonian Institution of the stranding of marine animals has already been productive of important results. The series of specimens thus far received is in every way remarkable, and should the system continue to be so productive it is impossible to say what good may not result to zoology. The first specimen received was that of a shark (*Pseudotriacis microdon*) from Station No. 10, Amagansett, N. Y., Mr. Joshua B. Edwards, keeper. This species had hitherto been captured only off the coast of Portugal, and its discovery in our waters was a matter of great interest to American ichthyologists. The only other specimen known to be preserved is the type of the species.

Shortly after this shark was received a still more remarkable animal was announced from Station No. 8, at Spring Lake, N. J., Mr. Henry S. Howland, keeper. This was a pigmy sperm-whale of the genus *Kogia*, a form entirely new to the North Atlantic. Few specimens of this genus have ever been collected, and these from the most remote parts of the globe, some from New Zealand, and one from Mazatlan, at the entrance of the Gulf of California. These animals resemble the great sperm-whale, to which they are closely related, but do not seem to attain a length of more than 9 or 10 feet, and are truly the pigmies of their race. The New Jersey specimen was peculiarly interesting in that it was a female with young. In dissecting the animal a fetus fully 3 feet long was found, which is probably the first ever seen by the naturalist.

The interest aroused by the arrival of this specimen had scarcely abated when the stranding of another cetacean was announced from Station No. 17, at Barnegat City, N. J., Mr. J. H. Ridgway, keeper. This remarkable animal floated in upon the tide and was secured by Mr. Ridgway and his crew after considerable exertion. The curator of mammals and an assistant were dispatched from the National Museum, and a cast of the exterior was made and the skeleton prepared for shipment to Washington. As the huge animal lay upon the sand the question of its identity proved quite a puzzling one to the zoologist who viewed it; but when the skull was cut out, it was at once apparent that the animal belonged to the whales known as the Ziphioids, and probably to the species *Ziphius cavirostris*, an animal for which no common name exists, but which may be termed a bottle-nose whale. It is probably the second specimen ever taken on the coast of the United States.

Ziphioid whales have a most interesting history. In ages past they were very abundant, perhaps as much so as the common porpoise of to-day, but at present only stragglers are found in remote quarters of the globe. It would seem as if they were but the surviving relics of a great race, which sprang into existence, reached the maximum of its abundance, and declined long ages before man appeared on the earth. Many species occur as fossils in connection with the phosphate deposits of South Carolina.

From Station No. 20, at Fire Island, N. Y., Mr. Daniel S. Hubbard, keeper, and Station No. 37, at Turtle Gut, N. J., Mr. Uriah Gresse, keeper, came two specimens of a porpoise, which, unlike the cetaceans which have been already referred to, is of common occurrence on our Atlantic coast, and is probably also represented in European waters. The casts, however, which the National Museum was enabled to make are probably the first of the species in any museum in the country, and, with the skeletons, which were preserved, form an excellent basis for comparison with other forms. The animal is commonly known as the bottle-nose dolphin, and is identical with or closely allied to the species *Tursiops truncatus*.

In addition to the shark previously mentioned, several peculiar and interesting fishes have been received. Among these is a fish known as the "star-gazer" (*Astroscopus anolophus*), from Station No. 6, at Deal's Island, N. C., Mr. Malachi Corbel, keeper. The "star-gazer" is a southern species which occasionally strays northward as far as Cape Cod, but it is very rare in museums. A very closely allied species (*anolophus* var. *græcum*) is said to possess electrical power in life. From Station No. 2, at Point Judith, R. I., Mr. Herbert M. Knowles, keeper, was received a specimen of the "lumpfish." The "lumpfish" (*Cyclopterus lumpus*) as a rule is an inhabitant of colder waters than that in which it was found. The "flute mouth" (*Fistularia serrata*), from the same station, is a very rare species on our coast. The "angel fish" (*Pomacanthus arcuatus*), taken at Barnegat City, N. J., has not hitherto been known north of Florida.

WAR DEPARTMENT.—Permission was given May 28th, by the Acting Secretary of War, for one of the steamers to land at the Arsenal wharf, and to occupy it whenever not engaged at the fisheries.

Engineer Bureau.—March 23d the Chief of Engineers, General H. G. Wright, granted permission to use the fishing-shore at Fort Washington for the purpose of propagating shad, with the understanding that the grounds should be vacated whenever the Department should so request. Subsequently a like permission was granted to use one of the buildings at the fort as headquarters for the men.

The Bureau furnished maps of the Columbia River, to be used in the tour of exploration by Mr. Livingston Stone.

Signal Office.—General Hazen furnished weather indications to the Lookout on the trip to South Carolina in the spring, and also sent

weather telegrams to Wood's Holl during the summer season. He also replaced several broken thermometers for the use of lighthouse keepers in taking temperature observations.

NAVY DEPARTMENT.—The officers and crews of all the vessels of the Fish Commission have been furnished by the Navy Department during the year, and all the facilities of the navy-yards, particularly that at Washington, have been extended.

Bureau of Construction and Repair.—March 22d the chief of this Bureau authorized the continued use of Navy launches Nos. 55 and 49. May 16th the chief of this Bureau gave instructions to the commandants at New York and Norfolk to dock and paint the Albatross.

Bureau of Equipment and Recruiting.—April 13th Commodore English authorized the detail of machinist, fireman, and seaman for the new launch. April 16th Commodore English authorized the commandants of the navy-yards at Boston, New York, Norfolk, and Washington, and the Superintendent of the Naval Academy at Annapolis, to furnish coal to Fish Commission vessels upon requisition. January 4th, at the request of Captain Tanner, an exchange of galleys was made between the Albatross and the Wyandotte.

Bureau of Ordnance.—April 13th the Bureau furnished a 3-inch breech-loading howitzer for the Albatross; also small-arms for the Albatross, and powder-tanks for use in making collections of specimens.

Naval Constructor Pook rendered assistance in making drawings for a fishing smack.

POST-OFFICE DEPARTMENT.—This Department established a post-office at the McCloud River salmon station, naming it Baird; and Mr. Radcliff was appointed postmaster January 18.

INTERIOR DEPARTMENT.—*Patent Office.*—The Commissioner of Patents has supplied the Commission with the Official Gazette, and other information with reference to patents relating to fish and fisheries apparatus.

B.—BY THE RAILROADS OF THE UNITED STATES.

In the earlier years of the work of the Commission the distribution of eggs and young fish was made in the baggage cars of the ordinary passenger trains, the special privilege being granted of having the fish carried without extra charge, and free access allowed to them on the part of the messengers of the Commission. The value of this concession may be readily understood from the fact that the equipment usually consisted of ten or twelve cans of 10 or more gallons capacity each, and requiring, of course, a large amount of standing room, and involving a great deal of wetting of the floor.

Nearly all the railroads in the United States cordially assented to this condition, an official circular being obtained from each one, which was carried by the messengers and presented on occasion. So hearty was the co-operation of the roads with this enterprise that cases were

not wanting where important freight was left behind in order to permit the fish to be carried through without detention.

Since the introduction, however, of transporting cars, this method of distribution has been very largely given up, being now employed only for service of localities within a few hundred miles of Washington.

While some railroads carried these cars free of any charge whatever, most of the others have exacted only a very trifling sum, generally 20 cents per mile for the car and five messengers, any additional number of messengers, when required, paying regular fares. The principal roads charging the twenty cents per mile, or thereabouts, are as follows:

Alabama Great Southern Railway; Chattanooga, Tenn.
Atchison, Topeka and Santa Fé Railroad; Topeka, Kans. (In part only. See below.)
Atlanta and West Point Railroad; Atlanta, Ga.
Baltimore and Ohio Railroad; Baltimore, Md.
Chesapeake and Ohio Railway; Richmond, Va.
Chicago and Northwestern Railway; Chicago, Ill.
Chicago, Burlington and Quincy Railroad; Chicago, Ill.
Chicago, Milwaukee and Saint Paul Railway; Chicago, Ill.
Cincinnati, Indianapolis, Saint Louis and Chicago Railway; Cincinnati, Ohio.
Columbus, Hocking Valley and Toledo Railway; Columbus, Ohio.
East Tennessee, Virginia and Georgia Railroad; Knoxville, Tenn.
Georgia Railroad; Augusta, Ga.
Illinois Central Railroad; Chicago, Ill.
Louisville and Nashville Railroad; Louisville, Ky.
Marietta and Cincinnati Railroad (now Cincinnati, Washington and Baltimore); Cincinnati, Ohio.
Minneapolis and Saint Louis Railroad; Minneapolis, Minn.
Nashville, Chattanooga and Saint Louis Railway; Nashville, Tenn.
New York and New England Railroad; Boston, Mass.
New York, New Haven and Hartford Railroad; New York, N. Y.
Pennsylvania Railroad; Philadelphia, Pa.
Pennsylvania Company:
  Jeffersonville, Madison and Indianapolis Railway; Louisville, Ky.
  Pittsburg, Cincinnati and Saint Louis Railway.
  Pittsburg, Fort Wayne and Chicago Railway.
Petersburg Railroad; Petersburg, Va.
Raleigh and Gaston Railroad; Raleigh, N. C.
Richmond and Danville Railway; Richmond, Va.
Richmond and Petersburg Railroad; Richmond, Va.
Richmond, Fredericksburg and Potomac Railroad; Richmond, Va.
Terre Haute and Indianapolis Railroad; Terre Haute, Ind.
Virginia Midland Railway; Alexandria, Va.
Western Railroad of Alabama; Montgomery, Ala.

The following roads performed this service free, except the Saint Louis, Keokuk and Northwestern, which made a charge of 10 cents per mile:

Missouri Pacific Railroad.
Saint Louis, Keokuk and Northwestern Railway.
Atchison, Topeka and Santa Fé Railroad.
Flint and Père Marquette Railway.
Utah Central Railroad.
Northern Pacific Railroad.

The Northern Pacific Railroad issued a free pass for Mr. Livingston Stone to traverse that line during his explorations of the Columbia River with a view of establishing a salmon hatchery.

C.—By Foreign Steamship Companies.

In addition to the companies that have heretofore rendered facilities, Messrs. Peter Wright & Sons, general managers of the Red Star Line, have offered to carry fish to Liverpool free of charge.

D.—By Foreign Countries.

Germany.—Several attempts were made by Herr von Behr to send some of the blue carp of Germany. During January a shipment of eight arrived to the care of Mr. Blackford, who forwarded them to Washington, but most of them died, having suffered from fungus and bruises. On May 8th, five were received in good condition from the *Deutsche Fischerei-Verein*, the survivors of forty which had been forwarded by Mr. Busse, of Geestemünde.

7.—Courtesies to foreign countries.

Nearly every year of the Fish Commission's existence eggs or fish have been sent to foreign countries in response to properly authenticated requests. Within the present year a larger number of applications have been made than usual. This has been caused, perhaps, by the success which has heretofore largely attended shipments abroad.

France.—On the 3d of January 200,000 whitefish eggs and 50,000 lake-trout eggs were placed on the steamer Labrador for transmission to the Society of Acclimation in Paris, where they arrived in perfect condition.

On the 6th of February 20,000 brook-trout eggs from the station at Northville were shipped from New York by steamer St. Laurent. Receipt of these in perfect condition was acknowledged by the society under date of March 3.

March 7th, 15,000 landlocked salmon eggs were forwarded by steamer to the same society. These are reported to have arrived in perfect condition March 31st. An illustration of the results of the efforts to acclimatize California salmon in France will be found in the Fish Commission Bulletin for 1884, page 138, from which it appears that at three different times salmon measuring from 25 to 30 centimeters in length have been taken in the river Aube, which were no doubt results of eggs sent by the U. S. Fish Commission in 1879, 1880, and 1881.

Germany.—On Saturday, January 6th, there were forwarded by a North German Lloyd steamer 25,000 brook-trout eggs, 100,000 lake-trout eggs, and 500,000 whitefish eggs. These were all for the *Deutsche Fischerei-Verein*, and were sent to the care of F. Busse, Geestemünde. Under date of January 19th, Herr von Behr announced the safe arrival of the whitefish eggs and the brook-trout eggs, but that, as many of the lake-trout eggs hatched out on the way, only about 30 per cent of

the lake-trout lot could be saved. On the 10th of March 25,000 landlocked salmon eggs were sent to the *Deutsche Fischerei-Verein* by steamer Neckar. Under date of April 1, Herr von Behr wrote that the landlocked salmon eggs "arrived in wonderful condition."

In February Mr. George Eckardt undertook to carry 7 large-mouth and 45 small-mouth black bass with him to Germany, and he arrived safely with the bass February 27. He delivered them to Max von dem Borne, at Berneuchen. Subsequently a large proportion of the fish died, probably in consequence of the long journey; but 3 of the former and 10 of the latter survived the winter of 1883–'84. The large-mouth bass spawned in the spring of 1884, and more than 2,000 young were obtained. Three of the old ones had grown very rapidly by this time, and measured more than 12 inches in length.

Great Britain.—On the 2d of February 10,000 brook-trout eggs were sent by Cunard steamer Catalonia to the Norfolk and Suffolk Acclimatization Society, of which Hon. W. Oldham Chambers is secretary. Under date of February 26th he reported their arrival in excellent condition.

On March 7th, 10,000 landlocked salmon eggs were forwarded by Cunard steamer Bothnia to the same address. Under date of April 6 the safe arrival of these eggs was announced. They also hatched with very small loss.

Belgium.—Application having been made by Hon. E. Williquet, of Ghent, for catfish, several efforts were made to forward them, but, the specimens offered being unsuitable, further efforts were deferred until another year. The White Star Line to Antwerp, Peter Wright & Sons, general managers, kindly offered to transmit the catfish free of charge.

Cuba.—Two large cans containing 26 carp were forwarded by steamer Newport from New York to Mr. Odvards, Havana, Cuba. Under date of March 17 he reported that 3 of them died during the trip and 7 after arrival, and that the remainder were in good condition.

Brazil.—Under date of January 6, Mr. J. W. Couchman, of Rio Janeiro, reported the safe arrival of 13 carp out of 100 that had been forwarded thirty-nine days previously from New York by the steamer Borghese.

United States of Colombia.—On the 14th of January Don Ricardo Becerra, of Bogota, received at New York 6,000 brook-trout eggs and 100 carp, which he took home with him to Bogota.

Mexico.—On the 25th of January there were forwarded to Mr. Blackford, New York, 50 carp, to be sent by the New York and Mexican Steamship Line to A. B. Clark, San Luis Potosi, care of Messrs. D'Oleire & Co.'s Successors, Vera Cruz, for Eugene Pigeon, San Luis Potosi.

8.—THE LONDON AND OTHER FISHERIES EXHIBITIONS.

In a previous report mention is made of the passage of an act by Congress authorizing and directing the participation by the United

States, through its Fish Commission, in the London International Fisheries Exhibition of 1883.

The preparations, begun in July, 1882, were carried on with great activity, and on the 26th of February a preliminary exhibition of such material as could conveniently be displayed was held in the National Museum, continuing two evenings and two days.

The work of packing the collections for transmission to London was begun on the 27th of February. The first shipment of goods was made on the 7th of March, the last on the 14th of April. A satisfactory arrangement was made, through the agency of Col. Thomas Donaldson, (1) with the Pennsylvania Railroad Company, for the transmission of the collections to New York and placing them on board of the steamer, and (2) with Messrs. Patton, Vickers & Co., agents of the Monarch Line of steamships between New York and London, for reduced freights, the rates given covering the transmission of the collections to London and back to New York.

The party accompanying the collections consisted of Mr. Goode, who, in the inability of the Commissioner of Fisheries to attend, was appointed special commissioner, Dr. Tarleton H. Bean, Mr. R. Edward Earll, Capt. Joseph W. Collins, Mr. A. Howard Clark, Mr. William V. Cox, Mr. Reuben Wood, and Capt. H. C. Chester. All of these gentlemen were permanent members of long standing of the staff of the Fish Commission and National Museum, excepting Mr. Wood, who was selected to represent the angling interests, being one of the champion fly-casters of the United States, and an expert in all matters relating to fine tackle. In addition to those already named, Lieut. C. H. McLellan, U. S. Revenue Marine, was detailed by the Life-Saving Service; Mr. Max Hansmann from the Light-House Board; and Sergt. James Mitchell, U. S. A., from the Signal Office, to accompany and instal the collections sent over by their respective departments. Mr. R. I. Geare also accompanied the party as stenographer for work upon the report.*

The collections arrived in London in excellent condition. It was soon found that the space of 10,000 feet asked for by the United States was entirely inadequate for the purposes, being inconveniently arranged and badly cut up by partitions and passage-ways. Additional, but insufficient, space was subsequently obtained in various parts of the exhibition grounds, the most useful portion being a section of about 2,500 feet graciously conceded by the Danish commissioner, Mr. Howitz. The life-boats were placed in a shed erected by us in one of the gardens,

* On March 20, Messrs. Earll, Clark, Cox, and Chester sailed from Philadelphia; on March 31, Messrs. Goode, Collins, Hansmann, and Mitchell; on April –, Messrs. McLellan and Wood; on June 16, Mr. Geare; and on June 30, Dr. Bean. Mr. Wood arrived home August 7; Mr. Clark, August 25; Lieut. McLellan, August 29; Mr. Hansmann, September 16; Mr. Geare, September 18; Messrs. Goode and Collins, September 30; Sergt. Mitchell, November 22; and Messrs. Earll and Cox, January 10. Captain Chester returned finally January 16, having made a trip to the United States, for the summer work of the Fish Commission, from July 16 to October 14.

three of the fishing boats upon the lake, and the salted, smoked, and preserved fish in a special building put up for articles of this description, in an unfortunately remote portion of the grounds.

The exhibition was held in the grounds of the Royal Horticultural Society in South Kensington, nearly on the sites of the great London exhibitions of 1851 and 1862. It was the largest special exhibition ever held, being participated in by thirty-one nations and colonies. The area occupied was 21 acres, about one-third of the space being covered with temporary buildings, and the remainder devoted to lakes and gardens, which were decorated and arranged in the most attractive manner, and afforded a delightful breathing and resting place for visitors to the exhibition.

Although conducted by a corporation of private citizens, the exhibition was practically a Government enterprise, its patron being Her Majesty the Queen, and the president the Prince of Wales. It was formally opened and closed by the Prince of Wales, in the presence of the court and its most prominent officials and promoters, who were men in high official position. The surplus proceeds are to be devoted to some public enterprise, such as the improvement of the condition of the fishermen's widows and orphans or the establishment of a zoological marine laboratory for the benefit of the fisheries.

The buildings assigned to the United States being of a temporary nature, mere rough sheds of unplaned boards, whitewashed with some fire-proof preparation, it was necessary to prepare them by painting them in distemper, both for appearance sake and to prevent the disfigurement of the collections from the constant shower of flakes of whitewash. This occasioned some delay, but by dint of hard labor, night and day, our party succeeded in getting the section into presentable form in time for the formal opening, which took place on the 12th of May, having been deferred nearly two weeks on account of the illness of the Queen.

After the opening, several weeks were occupied in attaching labels and finally adjusting the collections, but by June 1 everything was in thorough order, and the section was generally admitted to possess the greatest interest and to be the most important single division of the entire exhibition, both on account of its contents and the manner in which they were displayed. The following paragraph from the Pall Mall Gazette is a sample of several hundred of a similar tenor which might be quoted:

"The United States section is a department whose importance grows upon the inquiring visitor at every inspection. With fisherman and angler alike it holds the supreme position in the entire exhibition. The section forms a very flattering manifestation of international courtesy upon the part of the Government at Washington, for by far the largest part of the exhibits are from the National Museum and from the storehouses of the U. S. Fish Commission—an institution for which

it would be rather difficult to find an English counterpart—the private exhibitors, particularly trading exhibitors, being very few. Of the comprehensiveness and completeness of this truly national exhibition it is impossible to speak too highly."

Again, Major-General A. Pitt Rivers, a prominent ethnologist, in a letter to the editor of the Times, remarked as follows:

"In confirmation of the praise you justly bestow upon the arrangement of the United States department in the Fisheries Exhibition, I beg leave to draw attention to the fact that in the whole exhibition it is the only one which is arranged historically. In the Chinese, Japanese, Scandinavian, and Dutch courts, there are objects which the scientific student of the arts of life may pick out and arrange in their proper order in his own mind; but in that of the United States, * * * following the method adopted in the National Museum at Washington, [there has been] attempted something more to bring [the] department into harmony with modern ideas. * * * This gives the exhibition a value which is apart from commerce, and an interest which is beyond the mere requirements of fish-culture, and it may be regarded as one out of many indications of the way in which the enlightened Government of the United States marks its appreciation of the demands of science."

Again, Mr. James Russell Lowell, minister to England, in a dispatch to the Secretary of State, under date of May 19, wrote:

"I have the honor to report that the International Fisheries Exhibition promises to be far more successful than even the most sanguine of its projectors had ventured to hope. The wisdom of Congress in making so liberal an appropriation in furtherance of its object is entirely justified both by the substantial encouragement given to the enterprise at its inception by this proof of interest on the part of the United States, and by the fact that the section devoted to our country is more valuable than that of any other, and valuable for reasons of which we may very properly be proud.

"I have the highest authority for saying that, quite apart from any consideration of intrinsic interest or curiosity, our share in the exhibition is superior to all others, in virtue of the scientific intelligence shown in its arrangement and classification, thus rendering it more instructive than any other. This is especially gratifying, because it is a triumph of a far higher kind than could be won by any ingenuity in our contrivances for the breeding or mechanical perfection in our implements for the taking of fish, though in these also we may safely challenge and in some cases defy comparison.

"The credit of this unquestioned success is due undoubtedly, in the first place, to Professor Baird, whose absence is universally regretted, but hardly less to the intelligence, zeal, and untiring energy of Professor Goode and his assistants, who worked literally night and day in order to be ready for the day fixed for the opening of the exhibition.

"I shall naturally have occasion to write again and more fully on this

topic when more perfectly informed, but could not deny myself the pleasure of reporting to you the impression already made in this international competition by the genius for organization of which our countrymen have here given proof, a faculty certainly not the lowest among those that distinguish the social and civilized man."

These paragraphs are reprinted here simply to give an idea of the appreciative enthusiasm with which the participation of the United States in the Fisheries Exhibition was received in England. It was generally understood that the action of Congress in making an appropriation for this purpose decided the fate of the enterprise, in so far at least as its international character was concerned, since many nations which had before been undecided as to their action were finally influenced on account of this evidence of international courtesy and comity.

The members of our party express themselves as having been extremely gratified by the courtesy and aid which they received at the hands of the managers of the exhibition, particularly Mr. Edward Birkbeck, chairman of the executive committee, to whom, indeed, the inception and the success of the exhibition is mainly to be attributed; Professor Huxley; Sir Philip Cunliffe-Owen; Mr. A. J. R. Trendell, literary superintendent; Surgeon-General Francis Day; Mr. Fell-Woods; Mr. W. Oldham Chambers; and Sir James Gibson Maitland. From the opening of the exhibition, on May 12th, to its close, October 30th, the buildings and grounds were thronged with visitors, not only in the day but at night, when the buildings and grounds were illuminated by electric lights. The exhibition was a favorite resort for the London people through the summer, and was rendered more attractive by two daily open-air concerts by military bands. The total number of visitors was 2,690,000, an average of 18,545 per day.

On the 18th of June began the international fishery conferences at the exhibition, the opening address being given by Professor Huxley, the Prince of Wales in the chair. These conferences continued for nearly three months, taking place every day except Wednesday and Saturday, and two papers usually being read at each session. The chair was always taken by some distinguished man, and the reading of each paper was followed by general discussion. The attendance varied from one hundred to five hundred, a considerable number of the attendants being official delegates sent by the various Governments participating in the exhibition, selected on account of their familiarity with fisheries and kindred topics. About fifty papers were read, many of them of great importance, and dealing with subjects never before taken up for discussion. June 25 was devoted to the fisheries of the United States, and a paper was read by Mr. Goode upon "The Fishery Industries of the United States and the Work of the U. S. Fish Commission," Mr. James Russell Lowell presiding. In seconding the vote of thanks, Professor Huxley, in the course of his remarks, said: "The great moral of the United States contribution to this exhibition * * * was that if this country, or any society which could be formed of sufficient extent to take up the

question, was going to deal seriously with the sea fisheries, and not to let them take care of themselves, as they had done for the last 1,000 years or so, they had a very considerable job before them; and unless they put into that organization of fisheries the energy, the ingenuity, the scientific knowledge, and the practical skill which characterized his friend, Professor Baird, and his assistants, their efforts were not likely to come to very much good. One of his great reasons for desiring that the subject which * * * had been put before them should be laid distinctly before the English public was to give them a notion of what was needed if the fisheries were to be dealt with satisfactorily, for he did not think, speaking with all respect to the efforts made by Sweden, North Germany, Holland, and so forth, that any nation at the present time comprehended the question of dealing with fish in so thorough, excellent, and scientific a spirit as the United States."

The conference papers, with the discussions, have all been printed, and, together with a series of illustrated popular hand-books, the reports of the juries, and the prize essays, will make up a very important contribution to the literature of fish and fisheries, making about twelve volumes octavo. The catalogue of the exhibition is in itself a small cyclopedia of fisheries, the account of the exhibit of each country being prefaced by a description of its fisheries by some expert. The establishment of a literary bureau, in charge of Mr. Trendell, under whose direction the publications were issued, was an important advance in exhibition administration.

The juries began their work early in June, and continued their activity about two months. A certain amount of jury work was done at a later period, even after the official announcement of the awards—a kind of jury work which seems exceedingly desirable that exhibitions should avoid in the future, if the dissatisfaction still being manifested in England is to be taken as a criterion. The United States was well represented on the juries by Messrs. Earll, Clark, Collins, McLellan, and Hansmann. Mr. E. T. Russell, of Boston, and Mr. Romyn Hitchcock, of New York, who were at that time in London, also served on juries, and Mr. Goode acted as one of the special jury upon prize essays.

The success of the participation of the United States was greatly increased by the fact that so many experts were employed upon its staff, and were constantly in attendance to explain and give significance to the collections—Captain Collins in everything relating to sea fisheries, vessels, and boats; Mr. Earll in fish-culture and the lake fisheries; Dr. Bean in marine zoology; Captain Chester in whaling and sealing; Mr. Clark in fishery products; Lieutenant McLellan in life-saving apparatus; Mr. Hansmann in light-house affairs; Mr. Wood in angling and fine tackle; and Sergeant Mitchell in the work of the Weather Bureau. No such attempt was made by any of the other countries, but its success was so manifest that it is hoped that it may serve as a precedent in future exhibitions.

The presence of these specialists was also important in connection with the work on the official report upon the exhibition and on the present state of the fisheries of Europe, which is now being prepared in accordance with the provision of the act of Congress directing our participation, and which I shall have the honor of submitting within a few months. This report, in addition to the narrative and descriptive part and a general review of European fishing, written by Mr. Goode, will contain special reports by Mr. Earll, upon European fish-culture and the herring and sardine fisheries; by Captain Collins, upon trawl-net fishing, the cod and mackerel fisheries of Europe, and upon fishing vessels and boats; by Mr. Clark, upon the European methods of preparing fishery products and upon the world's commerce in fishery products; by Mr. Cox, upon the English fish trade; by Mr. Hitchcock, upon the scientific apparatus; and by Lieutenant McLellan, upon life-saving appliances.

During the exhibition Mr. Earll visited the Scotch herring-fisheries and the fish-cultural establishment of Sir James Maitland at Stirling, and Captain Collins visited various fishing stations upon the south coast of England, having during a previous visit, at the close of the Berlin Exposition, made a trip upon a Grimsby trawling cutter and studied the trawl-net fishery from a practical standpoint. Mr. Goode's attention, in his leisure time, was, by my direction, devoted chiefly to studying methods of museum management in the great establishments of England; he also made a flying trip to Paris to study the museum methods there, having three years previously visited those of Germany and Italy. Dr. Bean visited the natural-history museums of Liverpool, London, Paris, Geneva, Vienna, and Berlin, to make certain comparisons required in connection with the fishery work.

An international anglers' tournament was held June 11th at Welsh Park, Hendon, under the direction of the Fishing Gazette. On this occasion Mr. Reuben Wood won two of the prizes, (1) for amateur fly-casting with single-handed fly rod, and (2) for amateur fly-casting with a salmon rod, the distance cast in the first instance being 72½ feet, in the latter 108 feet, the wind being considered an unfavorable one. On the 4th of July a trial of life-saving appliances took place in the Serpentine, Hyde Park, in which several American devices proved satisfactory.

The exhibition was formally closed October 30th by the Prince of Wales, and the work of packing the collections for shipment was at once taken up by Messrs. Earll, Chester, and Cox, the other members of the party having returned to their posts in Washington before the close of the exhibition; and before the end of the year the entire collection, in all between 500 and 600 tons, cubic measurement, had been returned to Washington, and the work of setting it up in the permanent fisheries gallery of the National Museum had been begun. Many important accessions to the collection were received during the exhibition, chiefly

by exchange, prominent among which were collective exhibits from Greece, Spain, India, Sweden, and China; an Irish currack from the Marquis of Hamilton; illustrations of the net-maker's art, from Mr. W. B. Tegetmeier; a Danish vessel model, from Mr. Arthur Feddersen, of Viborg; &c. A considerable collection of fish-cultural appliances was given to the new National Fisheries Museum at South Kensington, in exchange for objects from India and China.

The prize list, as far as it can be tabulated from published official announcements up to April 1, 1884, stands as shown in the following table. Comment is unnecessary, except to remark that the United States has no reason to complain of its treatment at the hands of the juries, the acknowledgment of our participation in the substantial form of medallic awards being even greater than we had hoped for.

Eighteen gold medals and four silver ones were given to the Fish Commission, and one gold medal to the National Museum.

In addition to the medals and diplomas tabulated below there were received seven special money prizes, in value aggregating £65 sterling, or $325, and seventeen diplomas of honor, given for "special services rendered" in connection with the exhibition.

No.	Name of country.	Gold.	Silver.	Bronze.	Diplomas.	Total.
1	United States	50	47	30	24	151
2	Norway	29	70	40	7	146
3	Sweden	27	36	40	19	122
4	Canada	17	15	6	4	42
5	New South Wales	11	9	4	1	25
6	Newfoundland	10	9	4	3	26
7	Spain	9	17	13	3	42
8	Netherlands	8	11	6	5	30
9	Russia	7	21	19	6	53
10	India	4	5	4	2	15
11	Italy	4	3	2		9
12	France	3	6	8	3	20
13	Denmark	3	2	9	2	16
14	China	2	3		1	6
15	Tasmania	1	4			5
16	Greece	1	3			4
17	Bahamas	1	1	1	1	4
18	Chili		2	2		4
19	Germany		1	3	1	55
20	Belgium		1	3	1	5
21	Jamaica		1	2	5	8
22	Straits Settlements		1	2		3
23	Austro-Hungary		1			1
24	Tunis		1			1
25	Ceylon		1			1
26	Japan			2	1	3
	Total	184	271	200	89	747
	England, Ireland, and Scotland*	155	253	212	128	748
	Grand total	342	524	412	217	1,495

*Of the 155 gold medals awarded exhibitors of the United Kingdom, England received 110, Scotland 38, Ireland 7.

An International Exhibition of Agriculture and the Fisheries was held at Aalborg, Denmark, in June. In response to an invitation from the authorities, and with my approval, Mr. Goode sent over a number of objects which he had no room to display in London. The result was the award of a silver medal to the U. S. Fish Commission, and ten bronze medals to special exhibitors, chiefly of fishery products.

A detailed list of prize-winners both at London and Aalborg is given in the appendix to this report.

In closing the account of the fisheries exhibition it seems proper to mention by name the persons who contributed to its success, since in every instance their efforts were exerted far more strenuously than was required by their official duty. The following officers of the Musuem, some of whom were also on the staff of the exhibition, were directly engaged in selecting, labeling, and installing the collections: Mammals, Frederick W. True; aquatic birds, Robert Ridgway; aquatic reptiles and batrachians, Dr. H. C. Yarrow; fishes, Dr. Tarleton H. Bean; mollusks, Lieut. Francis Winslow, U. S. N.; aquatic invertebrates, fishing grounds, and scientific research, Richard Rathbun; apparatus and products of fishing, W. V. Cox and A. Howard Clark; boats and vessels, Capt. J. W. Collins; aboriginal fishing apparatus, J. King Goodrich; fish-culture, R. Edward Earll.

Mr. Henry W. Elliott, Mr. A. Z. Shindler, and Mr. Leopold Moeller, artists; Mr. T. W. Smillie, photographer; Messrs. Hornaday, Marshall, and Lucas, taxidermists; Messrs. Joseph and William Palmer and Mr. Hendley, modelers; Messrs. Hawley and Sweeney, preparators; and Mr. Curet, printer, also contributed largely to the success of the collection by their enthusiastic co-operation.

The co-operation of Messrs. Ferguson, McDonald, Atkins, Stone, and Clark in the preparation of the fish-cultural work was of great importance, as was also that of Messrs. Thomas Donaldson, E. G. Blackford, Barnet Phillips, W. A. Wilcox, A. R. Crittenden, James G. Swan, C. W. Smiley, and Henry Horan in various matters connected with the administration.

The important services of all those so briefly mentioned here will be described more fully in the special report on the exhibition; they are here referred to in order that formal acknowledgment may be made for their energetic and disinterested services in behalf of our display at the London Exhibition.

General E. H. Merritt and Col. L. G. Mitchell, consul-general and vice-consul of the United States in London, and Mr. W. J. Hoppin, secretary of legation, and Mr. William Wesley, should also be mentioned as having rendered important aid.

The official catalogue of the United States sections forms Bulletin 27 of the National Museum. It has been printed in parts, six of which were issued during the exhibition, viz:

		Pages.
A.	Preliminary catalogue and synopsis	107
B.	Collection of economic crustaceans, worms, echinoderms, and sponges, by Richard Rathbun	31
C.	Aquatic and fish-eating birds, by Robert Ridgway	46
D.	The whale fishery and its appliances, by J. T. Brown	116
E.	Collection of fishes, by Tarleton H. Bean	124
F.	Economic mollusca, apparatus and appliances used in their capture and preparation for market, by Lieut. Francis Winslow	81

Other parts will soon follow, viz:

G. Apparatus of scientific research, by Richard Rathbun.
H. Aquatic mammals, by Frederick W. True.
I. Fish-culture and its appliances, by R. E. Earll.
J. Fishing boats and vessels, by Joseph W. Collins.
K. Apparatus of fishing, by A. Howard Clark.

9.—PUBLICATIONS IN 1883.

Reports.—The Report for 1880 (volume viii), two-thirds of which had been previously put in type, was completed early this year, the entire volume, with indexes and illustrations, being approved June 30. During the summer the press-work and binding were attended to, and the volume was ready for distribution October 31.

The Report for 1881 (volume ix) was pushed rapidly forward, and by the close of the year it was all in type except about 100 pages.

Bulletins.—Of the Bulletin for 1882, 160 pages had been printed and distributed in signatures in 1882. The remainder of the volume, consisting of 467 pages in all, was put in type and distributed in signatures between January and July. The edition ordered by Congress was then printed, and the bound volumes were ready for distribution August 27.

The volume for the current year was commenced immediately on the completion of the preceding volume (July 1st), and on December 31st the entire volume was in type. The signatures were distributed to about two hundred correspondents as fast as issued, the closing signatures, containing the index, having been mailed January 4th, 1884.

Pamphlets.—The number of copies of the Reports and Bulletins for distribution being comparatively limited, pamphlet editions of many of the papers were issued for general distribution. During the current year the following were issued:

GOODE, G. BROWN. Materials for a history of the swordfishes.

[From Report for 1880, pp. 287–392, pl. 24, index.]

GOODE, G. BROWN, JOSEPH W. COLLINS, R. E. EARLL, and A. HOWARD CLARK. Materials for a history of the mackerel fishery.

BAIRD, SPENCER F. Inducements offered fishermen to furnish shad eggs for the U. S. Commission of Fish and Fisheries.

[From Bulletin for 1882, pp. 389–391.]

BAIRD, SPENCER F. Preliminary catalogue and synopsis of the collections exhibited by the U. S. Fish Commission and by special exhibitors, with a concordance to the official classification of the exhibition.

[London Exhibition, part A, pp. 107.]

RATHBUN, RICHARD. Collection of economic crustaceans, worms, echinoderms, and sponges.

[London Exhibition, part B, pp. 31.]

RIDGWAY, ROBERT. Catalogue of the aquatic and fish-eating birds exhibited by the U. S. National Museum.

[London Exhibition, part C, pp. 46.]

WINSLOW, FRANCIS. Catalogue of the economic mollusca and the apparatus and appliances used in their capture and preparation for market. Exhibited by the U. S. National Museum.

[London Exhibition, part D, pp. 86.]

BROWN, JAMES TEMPLE. The whale fishery and its appliances.

[London Exhibition, part E, pp. 116.]

BEAN, TARLETON H. Catalogue of the collections of fishes exhibited by the U. S. National Museum.

[London Exhibition, part F, pp. 124.]

EARLL, R. EDWARD. The Spanish mackerel, *Cybium maculatum* (Mitch.) Ag.; its natural history and artificial propagation, with an account of the origin and development of the fishery.

[From Report for 1880, pp. 395–426.]

MCDONALD, MARSHALL. Specifications for the superstructure of the fishway proposed for the Great Falls, Potomac River, Maryland, pp. 3.

BAIRD, SPENCER F. Report of the Commissioner for 1880. A.—Inquiry into the decrease of food-fishes. B.—The propagation of food-fishes in the waters of the United States.

[From Report for 1880, pp. xvii–xlvi.]

POTTS, EDWARD. Freshwater sponges: what, where, when, and who wants them.

[From Bulletin for 1883, pp. 389–391.]

Carp publications.—During the year 1883 two editions of Hessel's pamphlet entitled "The carp and its culture in rivers and lakes" were issued for general distribution.

An additional pamphlet was prepared by Mr. Charles W. Smiley, entitled "Carp and Carp ponds," containing: (1) Answers to 118 questions relative to German carp; (2) directions concerning the construction of carp ponds. This pamphlet of 16 pages was the result of an effort to put into the form of questions and answers the principal facts which the correspondence of the Commission had shown that farmers and others desired to have in reference to carp. The directions for constructing ponds were accompanied by 7 large illustrative figures.

Later in the season a pamphlet of 32 pages by the same author was issued, entitled "Notes on the edible qualities of German carp and hints about cooking them." This was prepared from replies from several hundred circulars, which were sent to all parts of the country, addressed to persons who had received carp in 1879 or 1880. The testimonies of several hundreds of these were given verbatim, and the general

tenor of their statements was highly satisfactory, indeed fully up to the claims which the Commission had from time to time made concerning the carp as a food-fish. A few criticisms and uncomplimentary remarks were elicited by this correspondence, but in nearly every case there was internal evidence that the critics had undertaken to eat carp during the spawning season, had spoiled the fish in cooking, or that the fish had been kept in very foul water without efforts being made to purify the flesh thereafter.

These publications are forwarded to correspondents requesting them, and in reply to letters of inquiry, thus saving a large amount of letter-writing.

Mr. Charles W. Smiley, Chief of the Division of Records, during the year has had entire charge of the preparation of all matter for the printer, the correcting of the proofs of text and plates, and all else relating to the proper presentation of the several volumes, pamphlets, and circulars, as well as of their distribution to correspondents and applicants.

10.—THE WOOD'S HOLL STATION.

One of the most important directions in which the work of the Commission can be extended is in the multiplication, by artificial propagation, of the sea fishes, which constitute by far the most valuable element of the American fisheries in general. In this, we of course include the shell-fish and lobster. In the report for 1878 will be found a full account of the first experiments in this direction made by the Commission upon the cod at Gloucester, Mass. The results were very satisfactory as far as they went, and it was shown that all the various problems in the case could readily be solved with favoring circumstances. Several difficulties, however, existed at Gloucester; first, the absence of facilities for penning up the live fish until their eggs became ripe and ready for impregnation; second, the impurity of the sea-water, which caused a constant deposit of mud upon the eggs, destroying them in large part; third, the inclemency of the winter, involving the stoppage of the circulation of the water by freezing, and the killing of the fish if kept in floating cars at the surface; fourth, the inability to find, at reasonable cost, a suitable wharf or building in which the work could be prosecuted.

In spite of all these obstacles, however, a large number of codfish were hatched out and placed in Gloucester Harbor, without much expectation of hearing further from them. The fish used for the purpose were the gray variety, believed to come from the off-shore banks to the coast of the mainland for the purpose of spawning, the winter season being the period of this migration. During the following summer, however, small cod of the gray or off-shore variety were met with around the wharves in the harbor, and at once attracted attention, such an occurrence being quite unheard of before. Again, the next year, these fish were found outside of the harbor, and of considerably larger size,

fairly representing the second year of growth. The third year they were taken of a still larger size, and farther north along the coast, the fish of this school being universally known as "Fish Commission cod."

The codfish is, of course, taken freely on the Massachusetts coast during the summer season; but it is for the most part the rock or reddish cod, and not the gray or Banks cod, and is not of much commercial importance.

Subsequent to 1878 a careful search was prosecuted to find a location for the construction of a permanent hatching establishment for the marine fish; Noank, Stonington, Newport, Provincetown, and Wood's Holl passing successively in review. The last-mentioned place, however, was the only one that combined the necessary requirements to any reasonable degree.

The facilities heretofore furnished the Commission by the Light-House Board on its wharf (at Wood's Holl) were found entirely inadequate to the occasion, especially as the water of the Little Harbor was not satisfactory; a location was, however, found on a rocky point on the Great Harbor which it was believed would answer all the necessary purposes.

The river and harbor bill of the spring of 1882 included an appropriation for the construction of a harbor of refuge at Wood's Holl, and the Chief Engineer of the Army sanctioned some special adaptations of the plan of construction to meet the wants of the Fish Commission.

The projecting point in question, which it was desired to utilize as a station, formed part of a plot of ground belonging to Messrs. Isaiah Spindel & Co., of Wood's Holl, who offered it at the sum of $7,250. For various reasons it was thought best to raise this amount by private subscription, the money to be paid and the land presented to the United States in the event of the actual construction by the Government of the pier and breakwater referred to. The money was accordingly furnished by the following parties:

Old Colony Railroad Company	$2,500
John M. Forbes	1,000
Alexander Agassiz	500
Johns Hopkins University	1,000
Princeton College	1,000
Williams College	500
Isaiah Spindel & Co	500
Mrs. Robert L. Stuart	250

The colleges in question and Mr. Agassiz made their contribution with the understanding that, as far as possible, they were each to be allowed to send one specialist to the station for the purpose of carrying on scientific research.

In addition to these contributions, Mr. Joseph S. Fay, of Wood's Holl, presented to the United States a very valuable shore line, extending from the lot of Isaiah Spindel & Co., just referred to, to the grounds of the Pacific Guano Company; thus assuring a long stretch of shore where no buildings likely to be detrimental to the business of the Commission could be erected.

By direction of the Attorney-General of the United States, Hon. George P. Sanger, United States district attorney for Massachusetts, carefully investigated the titles of Messrs. Fay and Isaiah Spindel & Co., and pronounced them to be valid.

The property was then conveyed to two trustees, C. F. Choate, president of the Old Colony Railroad Company, and Mr. J. Malcolm Forbes, with the understanding, as stated, that whenever the work on the pier was formally begun the shore line should be transferred to the United States for the purposes of the U. S. Fish Commission, the value of the ground thus acquired being not less than $15,000. The transfer being made, the whole transaction was submitted again to the Attorney-General and received his sanction.

In the mean time, an appropriation of $25,000 had been made by Congress to commence the construction of the necessary buildings, and the plans of Mr. Robert H. Slack, of Boston, being selected, a contract was made with Mr. W. R. Penniman, of South Braintree, Mass., for the erection of the first building. Ground was broken in August, 1883, and by the end of the year the building was under roof.

Concurrently with the work on the foundations of the quarters building, the dredging of the trenches for building the piers of the engineer work was carried on, although, owing to the inefficiency of the dredge, not much work was accomplished during the year.

The series of buildings desired for the Commission was as follows:

1. A building available for offices, and for storage of boats and other property, and for hatching purposes; also for quarters for the persons occupied at the establishment during the several seasons of the year; this to include the necessary accommodations for the mess.*

As there was no assurance that another appropriation would be made by which to complete the series, this building was arranged to supply all requirements on a limited scale, and the expenditure of the appropriation was limited to this building and the next.

2. A reservoir with suitable pumping facilities, in which could be stored salt and fresh water, and from which it could be distributed to different parts of the establishment.

3. A fish-hatching building, where the work of fish propagation could be conducted, and which should also furnish facilities for the collateral operations authorized by Congress.

4. A coal shed, where a supply of coal for the steamers of the commission could be kept.

5. A storehouse for keeping supplies.

It was expected to utilize the pier and breakwater to be constructed

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* Heretofore, in order to meet the needs of the party working at the summer station, a mess had been organized which was furnished accommodations in one of the hired buildings. This was a self-supporting affair, managed by a caterer who paid all expenses for provisions and service from the mess fund, which was kept up by the payment of $1 per day by each member.

by the engineer department, by establishing it as a marine station for the accommodation of the Albatross, Fish Hawk, Lookout, &c., and for basins in which to keep the fish, lobsters, &c., undergoing treatment.

The building for the quarters was the first to be constructed, in view of the impossibility of obtaining the necessary accommodations in the village of Wood's Holl. The place is without any hotel, and has but a single boarding-house, which is generally filled in the summer season by regular boarders. During 1881, 1882, and also 1883, the Commission was obliged to scatter all over the village, renting three buildings for offices and other purposes, and obtaining single rooms wherever they could be had. It was considered of the utmost importance in the interest of economy and of efficiency to concentrate all this force, so that the business of the Commission could be properly transacted; and it is hoped that the report for 1884 will chronicle the completion of this work, and the successful commencement of the fish-hatching and other operations.

The work at the station for the year was quite similar to that of 1882, except that by means of the Albatross a much wider range of research was prosecuted, as will be seen in the special paragraph on that vessel.

As usual, a large number of scientific specialists, partly connected with the Commission and partly volunteers from the colleges of the country, were present; and great additions were made to our knowledge of the animal forms of the sea, and their mutual relationships and dependencies. As heretofore, collections in great magnitude were obtained, and taken to Washington at the close of the season, the duplicates, after supplying the National Museum, to be made up in sets for distribution, on the indorsement of members of Congress, to the various colleges and academies throughout the country.

This subsidiary work of the Commission has proved to be very acceptable to all persons interested, bringing to educational institutions in the far West the same facilities for instruction in marine natural history as were previously possssed only by those situated near the seaboard.

I refer to the report of the Commissioner for the year 1882 for further and minuter details in regard to the early history of the project for a permanent station, and the steps leading to its realization.

11.—VISITS FROM FOREIGN SPECIALISTS.

On the 5th of March Capt. G. M. Dannevig, of Arendal, Norway, visited Washington for the special purpose of ascertaining the methods adopted by the U. S. Fish Commission in hatching cod, with a view to introducing them into his country where (particularly on the southern coast) cod and other fishes appear to be rapidly diminishing. Every facility was given him for studying the subject, and after his return to Norway he made a quite successful experiment. He used the

Clark hatching-box in preference to other apparatus brought to his attention.

Mr. Henry Grosjean was sent by the French department of agriculture to study up several subjects. He paid particular attention to the work of the Fish Commission, and on his return to France prepared an elaborate report to the minister.

12.—PROVISION FOR THE EVENT OF DISABILITY OF THE COMMISSIONER.

In view of there being no provision of law by which the functions of the Commissioner of Fish and Fisheries could be exercised, in case of his absence or disability, an act was passed by Congress, and approved March 3, 1883, to remedy this defect.

In pursuance of this authority Mr. T. B. Ferguson was designated as Assistant Commissioner on the 7th of July, and a letter was transmitted to the Secretary of the Treasury notifying him of the fact.

B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

13.—THE INVESTIGATION OF THE MENHADEN FISHERY BY THE SENATE COMMITTEE.

The appointment of a subcommittee of the Senate to investigate the subject of the menhaden fishery was chronicled in the report of 1882, and a résumé given therein of what was accomplished, leaving the work to be continued in 1883.

The investigation was appointed to begin between the 20th of June and the 4th of July, with sessions at Atlantic City, Asbury Park, Long Branch, and Brighton Beach, and the Commissioner was invited to accompany the committee either personally or by proxy.

Mr. Marshall McDonald was accordingly designated to represent the Fish Commission, and on July 11 wrote from Cape May that the investigation had commenced, the three Senators being present. Senator Sewell and several representative men of New Jersey were also there to testify. The committee had asked for the use of the Fish Hawk, but as she was engaged in Spanish mackerel and oyster work it was not found possible to divert her from that duty. Later the committee proceeded to Portland, Me., where the last session was held July 25. On the way to Portland several sessions were held in Boston. On the 4th of October Senator Lapham applied for the steamer Lookout, with which to reopen the investigation in the Chesapeake. He was accordingly met by Mr. McDonald at Fortress Monroe October 12, where they established their headquarters, and, with the aid of the Lookout, visited the menhaden factory of Darby & Smithers at Back River, and other points. The testimony taken by the committee has been published by order of the Senate.

14.—THE FISHERY CENSUS OF 1880 AND ITS RESULTS.

As stated in preceding reports, an arrangement was made with General Francis A. Walker, Superintendent of the Tenth Census, in 1879, by which an investigation of the fisheries of the United States was undertaken as the joint enterprise of the U. S. Fish Commission and of the Census Bureau. It was decided that this investigation should be as exhaustive as possible, and that both the U. S. Fish Commission and the Census should participate in its preparation. The making up of a statistical and historical account of the fisheries, in general, to be published in the report of the Superintendent of the Census, was from the first the main object, but in connection with this, exhaustive investigations into the methods of the fisheries, the location and extent of the fishing grounds, and the natural history of useful marine animals were carried on.

The details of the proposed research were drawn up before the beginning of the work, and were published in an octavo pamphlet of fifty-four pages, entitled "Plan of Inquiry into the History and Present Condition of the Fisheries of the United States. Washington, Government Printing Office, 1879," and was reproduced in the 1880 Report, Part VIII, pp. 3–52.

The expense of the field-work from July 1, 1881, was for the most part borne by the Census, together with a large amount of compilation work carried on by clerks detailed from the Census Office in Washington. That involved in the preparation of the report, final tabulation of statistics of production, and preparation of illustrations has been mainly at the cost of the Fish Commission. Since February, 1881, Mr. Goode's connection with the Census Office has been purely nominal, and his services in the preparation of the reports and in connection with their publication have been rendered without compensation, in addition to his regular duties as assistant director of the National Museum. In the same manner a large share of the most important work upon special parts of the report has been the volunteer labor of officers of the National Museum and Fish Commission, in addition to their regular duties. A number of employees of the Fish Commission were detailed from time to time for special work upon this report, for periods varying from four months to two years.

The participation of the Census Office and the Commission of Fish and Fisheries has involved the expenditure of probably nearly equal amounts of money, and the division of the results, so far as they are represented in reports ready for the printer, has been arranged to the satisfaction of both. The extent of the material collected has, however, been much greater than was anticipated, and the portion assigned to the Fish Commission being too bulky for publication in the annual reports, application was made to Congress for permission to print as a separate special report an illustrated work in quarto upon the Food-Fishes and Fisheries of the United States.

This permission was granted in a joint resolution, which passed the Senate July 16, 1882.*

The manuscript of the entire report is for the most part ready for the printer, and several hundred drawings for the illustrations are finished. Part I was placed in the hands of the printer in August, 1882, and would have been published during the present year but for the absence of Mr. Goode in England in the performance of other duties in connection with the Commission. The contents of these reports will approximately be as follows, though it is probable that other topics may be added to the discussion before the work is completed:

THE FOOD-FISHES AND FISHERY INDUSTRIES OF THE UNITED STATES.

PART I.—The Natural History of Useful Aquatic Animals.
II.—The Fishing-Grounds.
III.—The Fishing Towns, containing a geographical review of the Coast, River, and Lake Fisheries.
IV.—The Fishermen.
V.—The Apparatus of the Fisheries and Fishing Vessels and Boats.
VI.—The Fishery Industries, a discussion of methods and history.
VII.—The Preparation of Fishery Products.
VIII.—Fish-Culture and Fishery Legislation.
IX.—Statistics of Production, Exportation, and Importation. Summary Tables.
X.—The Whale Fishery; a special monograph.
XI.—A Catalogue of the Useful and Injurious Aquatic Animals and Plants of North America.
XII.—A List of Books and Papers relating to the Fisheries of the United States.
XIII.—A General Review of the Fisheries, with a statistical summary.

The report prepared for the Superintendent of the Census, the manuscript of which is now for the most part in his possession, is divided into the following sections:

A REPORT UPON THE STATISTICS OF THE FISHERIES AND FISH TRADE OF THE UNITED STATES.

Introduction (giving a comprehensive abstract of the matter contained in the quarto report referred to above).
PART I.—A Review of the Fisheries of the Atlantic Seaboard, with statistics of production and manufactures.
II.—A Review of the Fisheries of the Pacific Coast, with statistics of production and manufactures.
III.—A Review of the Fisheries of the Great Lakes, with statistics of production and manufactures.
IV.—A Review of the River Fisheries of the United States. (Prepared by C. W. Smiley.)
V.—A Review of the Consumption of Fish by Counties, with an estimate of the extent and value of the inland fisheries. (Prepared by C. W. Smiley.)

* For text of bill, see Report U. S. F. C., 1882, Part X, p. xlvii.

PART VI.—A Review of the Fish Trade of cities of the United States having a population of more than 10,000 in 1880. (Prepared by C. W. Smiley.)

VII.—Statistics of Importation and Exportation of Fishery Products from 1730 to 1880.

VIII.—List of the Fishing Vessels of the United States in 1880, giving tonnage, value, number of crew, name of owner, branches of fisheries engaged in, together with other important details.

IX.—Monograph of the Seal Islands of Alaska. By Henry W. Elliott. (Already in type; 171 pages. 4to.)

X.—Monograph of the Oyster Fisheries. By Ernest Ingersoll. (Already in type; 251 pages.)

This series includes all compilations from circulars, and the results of the work performed by clerks detailed from the Census Office, together with much derived from the archives of the Fish Commission.

The first three sections are mainly made up from the material collected by the special agents in the field, and the form is as nearly as possible that in which it was originally collected; much, however, has been added from the archives of the Commission.

By the plan just detailed the statistical matter gathered by the joint efforts of the two organizations is assigned to the Census, together with a sufficient amount of descriptive and explanatory text to make the statistics fully intelligible, while the descriptive, historical, and natural history papers are taken by the Fish Commission, these being enriched by a sufficient amount of statistical detail to render them as useful as possible for the class of readers and students for whom they are intended.

The statistical results of the investigations have already been published in a preliminary way. A series of special statistical tables appeared in the bulletins of the Census Office, as follows:

(1) Census Bulletin No. 176.—[Preliminary report upon the Pacific States and Territories] prepared by Mr. Goode from returns of Special Agents Jordan, Swan, and Bean. Dated May 24, 1884. 4to. pp. 6 (+2).

(2) Census Bulletin No. 261.—Statistics of the Fisheries of the Great Lakes. Prepared by Mr. Frederick W. True from notes of Special Agent Kumlien. Dated September 1, 1881. 4to. pp. 8.

(3) Census Bulletin No. 278.—Statistics of the Fisheries of Maine. Prepared by Mr. R. E. Earll from his notes and those of Mr. C. G. Atkins. Dated November 22, 1881. 4to. pp. 47 (+ 1).

(4) Census Bulletin No. 281.—Statistics of the Fisheries of Virginia. Prepared by Col. Marshall McDonald. Dated December 1, 1881. 4to. pp. 8.

(5) Census Bulletin No. 291.—Statistics of the Fisheries of New Hampshire, Rhode Island, and Connecticut. Prepared by Mr. A. Howard Clark. Dated April 5, 1882. 4to. pp. 7 (+1).

(6) Census Bulletin No. 295.—Statistics of the Fisheries of Massachusetts. Prepared by Mr. A. Howard Clark from returns of Special Agents Wilcox, Clark, True, Collins, and Atwood. Dated March 1, 1882. 4to. pp. 35 (+ 1).

(7) Census Bulletin No. 297.—Commercial Fisheries of the Middle States. Prepared by Mr. R. E. Earll and Col. M. McDonald. Dated June 5, 1882. 4to. pp. 14. (This bulletin includes statistics of No. 4. C. B. No. 281.)

(8) Census Bulletin No. 298.—Commercial Fisheries of the Southern Atlantic States. Prepared by Mr. R. E. Earll and Col. M. McDonald. Dated June 5, 1882. 4to. pp. 18.

In all 148 pages, quarto.

In addition to these, certain special tables have appeared:

(9) Statistical Table.—Statistics of the Fisheries of the United States in 1880. [Prepared by Messrs. Goode and Earll from the reports of special agents.] Printed in Compendium of the Tenth Census, p. 88. pp. —. Republished in Bulletin of the U. S. Fish Commission, vol. iii, 1883, pp. 270–271, and in Preliminary Catalogue, International Fisheries Exhibition, January, 1883, p. 5.

(10) Statistical Table.—Table showing by States the quantity of Spanish mackerel taken in 1880, and the total catch for the United States. By R. Edward Earll. Report U. S. Fish Commission. Part VIII, 1880, p. 416.

(11) Statistical Summary.—Statistics of the Davis Strait Halibut Fisheries. By Newton P. Scudder. Report U. S. Fish Commission. Part VIII, pp. 190–192.

(12) Statistical Summary.—Statistics of the Swordfish Fishery. By G. Brown Goode. Report U. S. Fish Commission. Part VIII, pp. 361–367.

(13) Statistical Summaries.—Statistics of the Mackerel Fishery in 1880. By R. Edward Earll. Report U. S. Fish Commission. Part IX, pp. [124]–[127].

[Statistics of the Mackerel Canning Industry.] By R. Edward Earll. Ibid, p. [131].

Statistics of the inspection of mackerel from 1804 to 1880. By A. Howard Clark. Ibid, pp. [162]–[213].

Vessels in the Mackerel Fishery in 1880. Ibid, p. [418].

Catch of mackerel by Americans in Canadian waters, 1873–'81. Ibid, p. [430].

(14) Introduction to Section B., U. S. Catalogue International Fishery Exhibition, London. (Collection of Economic Crustaceans, Worms, Echinoderms, and Sponges.) By Richard Rathbun. pp. [3]–[20]. Crabs, p. [3]; Lobsters, p. [6]; Crayfish, p. [10]; Shrimps and Prawns, p. [11]; Sponges, p. [18]; &c.

(15) Introduction to Section D., U. S. Catalogue International Fishery Exhibition. (Catalogue of the Economic Mollusca and the apparatus and appliances used in their capture and preparation for market, exhibited by the U. S. National Museum.) By Lieut. Francis Winslow, U. S. N. pp. [3] to [58]. Aggregate table of production, p. [3]; special tables and statistical tables throughout.

(16) Introduction to Section E., U. S. Catalogue International Fishery Exhibition. (The whale fishery and its appliances). By James Temple Brown. pp. [3]–[25].

(17) Statistics of the Whale Fishery. By A. Howard Clark, in the preceding, pp. [26]–[29].

(18) A review of the fishery industries of the United States, &c. By G. Brown Goode. An address at a conference of the International Fishery Exhibition, June 25, 1883. 8vo., pp. 84. Numerous statistical statements, summaries, and tables.

(19) Administrative Report.—Method and results of an effort to collect statistics or the fish trade and consumption of fish throughout the United States. By Charles W. Smiley. Bulletin U. S. Fish Commission, vol. ii, 1882, pp. 247–252.

Two special reports have also been published as follows:

(20) A monograph of the Seal Islands of Alaska. By Henry W. Elliot. 4to., illustrated. pp. 172. An edition of this report with substitutions on pp. 102–109 was also issued as a special bulletin of the Fish Commission, No. 176.

(21) The Oyster Industry. By Ernest Ingersoll. 4to., illustrated. pp. 252.

Part I of the special report on the Food-Fishes and Fishery Industries of the United States, ordered by Congress July 16, 1882, has been put in type, as has been stated, and at the end of the year was awaiting the completion of the engraved plates. This volume, devoted to the natural history of the useful aquatic animals, contains 895 pages quarto. The character of its contents may best be indicated by the following analysis:

PART I.—MAMMALS.
- A. Whales and porpoises. By G. Brown Goode
- B. Seals and walruses. By Joel A. Allen.
- C. Habits of the fur-seal. By Henry W. Elliott.
- D. Manatees and the arctic sea-cow. By Frederick W. True.

PART II.—REPTILES AND BATRACHIANS. By Frederick W. True.
- E. The alligator and crocodile.
- F. Tortoises, turtles, and terrapins.
- G. The amphibians.

PART III.—FISHES. By G. Brown Goode. With discussions of species, by David S. Jordan and Tarleton H. Bean, notes on the fishes of the Gulf of Mexico by Silas Stearns, and contributions from Joseph W. Collins, N. E. Atwood, Marshall McDonald, R. Edward Earll, Ludwig Kumlien, and other authorities.
- H. The file-fishes, pipe-fishes, and anglers.
- I. Flat-fishes and flounders.
- J. The cod family and its kindred.
- K. Wolf-fishes, sculpins, and wrasses.
- L. Mackerel and its allies.
- M. The tilefish family and others.
- N. The drum family.
- O. The sheepshead, bass, bream, perch, &c.
- P. Barracuda, mullet, pike, and mummachog.
- Q. The salmon tribe.
- R. The herring and the menhaden.
- S. The shad and the alewives.
- T. Families related to the Clupeidæ.
- U. Carp, suckers, catfish, and eels.
- V. Sturgeons, skates, sharks, and lampreys.

PART IV.—MOLLUSKS.
- W. Mollusks in general. By Ernest Ingersoll.
- X. The life history of the oyster. By John A. Ryder.

PART V.—CRUSTACEANS, WORMS, RADIATES, AND SPONGES. By Richard Rathbun.
- Y. Crustaceans.
- Z. Worms.
- Za. The radiates.
- Zb. The poriferans.

This constitutes the first volume of this series and will be illustrated by 432 engravings of aquatic animals, arranged upon 277 plates.

Part II of the same work, consisting of a treatise upon the fishing-grounds of North America, by Richard Rathbun and Capt. Joseph W. Collins, has been sent to the printer.

Nothing has been printed by the Census Office excepting a summary table of the fisheries in the Compendium published during the present year, which is here reproduced:

Statistics of the fisheries of the United States in 1880.

	States and Territories.	Grand total.			Persons employed.		Apparatus and capital.		
							Vessels.		
		Persons employed.	Capital invested.	Value of products.	Fishermen.	Shoresmen.	Number.	Tonnage.	Value.
		No.	*Dollars.*	*Dollars.*	*No.*	*No.*			*Dollars.*
	The United States	131, 426	37, 955, 349	43, 046, 053	101, 684	29, 742	6, 605	208, 297. 82	9, 357, 282
	New England States	37, 043	19, 937, 607	14, 270, 393	29, 838	7, 205	2, 066	113, 602. 59	4, 562, 131
	Middle States, exclusive of Great Lake fisheries	14, 981	4, 426, 078	8, 676, 579	12, 584	2, 397	1, 210	23, 566. 93	1, 382, 000
	Southern Atlantic States	52, 418	8, 951, 722	9, 602, 737	38, 774	13, 644	3, 014	60, 886. 15	2, 375, 450
	Gulf States	5, 131	545, 584	1, 227, 544	4, 382	749	197	3, 009. 86	308, 051
	Pacific States and Territories	16, 803	2, 748, 383	7, 484, 750	11, 613	5, 190	56	5, 463. 42	546, 450
	Great Lakes	5, 050	1, 345, 975	1, 784, 050	4, 493	557	62	1, 768. 87	183, 200
1	Alabama	635	38, 200	119, 275	545	90	24	317. 20	14, 585
2	Alaska	6, 130	447, 000	2, 661, 640	6, 000	130	.....	....	....
3	California	3, 094	1, 139, 675	1, 860, 714	2, 089	1, 005	49	5, 246. 80	535, 350
4	Connecticut	3, 131	1, 421, 020	1, 456, 866	2, 585	546	291	9, 215. 95	514, 050
5	Delaware	1, 979	268, 231	997, 695	1, 662	317	69	1, 226. 00	51, 600
6	Florida	2, 480	406, 117	643, 227	2, 284	196	124	2, 152. 97	272, 645
7	Georgia	899	78, 770	119, 993	809	90	1	12. 00	450
8	Illinois	300	83, 400	60, 100	265	35	3	209. 73	8, 500
9	Indiana	52	29, 360	32, 740	45	7	1	21. 90	2, 500
10	Louisiana	1, 597	93, 621	392, 610	1, 300	297	49	539. 69	20, 821
11	Maine	11, 071	3, 375, 994	3, 614, 178	8, 110	2, 961	606	17, 632. 65	633, 542
12	Maryland	26, 008	6, 342, 443	5, 221, 715	15, 873	10, 135	1, 450	43, 500. 00	1, 750, 000
13	Massachusetts	20, 117	14, 334, 450	8, 141, 750	17, 165	2, 952	1, 054	83, 232. 17	3, 171, 189
14	Michigan	1, 781	442, 665	716, 170	1, 600	181	36	914. 42	98, 500
15	Minnesota	35	10, 160	5, 200	30	5	1	33. 59	5, 000
16	Mississippi	186	8, 800	22, 540	110	76	.....	....	....
17	New Hampshire	414	209, 465	176, 684	376	38	23	1, 019. 05	51, 500
18	New Jersey	6, 220	1, 492, 202	3, 176, 589	5, 659	561	590	10, 445. 00	545, 900
19	New York	7, 266	2, 629, 585	4, 380, 565	5, 650	1, 616	541	11, 582. 51	777, 600
20	North Carolina	5, 274	506, 561	845, 695	4, 729	545	95	1, 457. 90	39, 000
21	Ohio	1, 046	473, 800	518, 420	925	121	9	359. 51	38, 400
22	Oregon	6, 835	1, 131, 350	2, 781, 024	2, 795	4, 040	.....	....	....
23	Pennsylvania	552	119, 810	320, 050	511	41	11	321. 99	10, 500
24	Rhode Island	2, 310	596, 678	880, 915	1, 602	708	92	2, 502. 77	191, 850
25	South Carolina	1, 005	66, 275	212, 482	964	41	22	337. 32	15, 000
26	Texas	601	42, 400	128, 300	491	110	.....	....	....
27	Virginia	18, 864	1, 914, 119	3, 124, 444	16, 051	2, 813	1, 446	15, 578. 93	571, 000
28	Washington	744	30, 358	181, 372	729	15	7	216. 62	11, 100
29	Wisconsin	800	222, 840	253, 100	730	70	11	220. 25	26, 700

Statistics of the fisheries of the United States in 1880.

Apparatus and capital—cont'd.				Value of products by fisheries.							
Boats.		Value of minor apparatus and outfits.	Other capital, including shore property.	General fisheries.	Whale fishery.	Seal fishery.	Menhaden fishery.	Oyster fishery.	Sponge fishery.	Marine salt industry.	
Number.	Value.										
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dolls.*	*Dolls.*	
44,804	3,465,393	8,145,261	17,987,413	22,405,018	2,323,943	2,289,813	2,116,787	13,403,852	200,750	305,890	
14,787	739,970	5,038,171	9,597,335	10,014,645	2,121,385	111,851	539,722	1,478,900	......	3,890	
8,293	546,647	674,951	1,822,480	2,882,294	....	....	1,261,385	4,532,900	......	......	
13,331	640,508	1,145,878	4,789,886	2,217,797	408	....	315,680	7,068,852	......	......	
1,252	50,173	52,823	134,537	713,594	....	....	....	313,200	200,750	......	
5,547	404,695	467,238	1,330,000	4,792,638	202,150	2,177,962	....	10,000	......	302,000	
1,594	83,400	766,200	313,175	1,784,050	....	....	....	....	......	......	
119	10,215	7,000	6,400	74,325	....	....	....	44,950	......	......	1
3,000	60,000	7,000	380,000	564,640	500	2,096,500	....	....	......	......	2
853	91,485	205,840	307,000	1,341,314	201,650	15,750	....	....	......	302,000	3
1,173	73,585	375,535	457,850	383,887	32,048	111,851	256,205	672,875	......	......	4
839	33,227	70,324	113,080	309,029	....	....	941	687,725	......	......	5
1,058	28,508	39,927	65,037	426,527	....	....	....	15,950	200,750	......	6
358	15,245	18,445	44,450	84,993	....	....	....	35,000	......	......	7
101	2,000	11,900	61,000	60,100	....	....	....	....	......	......	8
15	1,650	20,210	5,000	32,740	....	....	....	....	......	......	9
165	4,800	18,000	50,000	192,610	....	....	....	200,000	......	......	10
5,920	245,624	934,593	1,562,235	3,576,678	....	....	....	37,500	......	......	11
2,825	186,448	297,145	4,108,850	479,388	....	....	11,851	4,730,476	......	......	12
6,749	351,736	3,528,925	7,282,600	5,581,204	2,089,337	....	61,769	405,550	......	3,890	13
454	10,345	272,920	60,900	716,170	....	....	....	....	......	......	14
10	900	3,760	500	5,200	....	....	....	....	......	......	15
58	4,600	1,600	2,609	12,540	....	....	....	10,000	......	......	16
211	7,780	60,385	89,800	170,834	....	....	....	6,050	......	......	17
4,065	223,963	232,339	490,000	949,678	....	....	146,286	2,080,625	......	......	18
3,441	289,885	390,200	1,171,900	1,689,357	....	....	1,114,158	1,577,050	......	......	19
2,714	123,175	225,436	118,950	785,287	408	....	....	60,000	......	......	20
487	29,830	253,795	151,775	518,420	....	....	....	....	......	......	21
1,360	246,600	245,750	639,000	2,776,724	....	4,300	....	....	......	......	22
156	13,272	40,538	55,500	132,550	....	....	....	187,500	......	......	23
734	61,245	138,733	204,850	302,242	....	....	221,748	356,925	......	......	24
501	9,790	25,985	15,500	192,482	....	....	....	20,000	......	......	25
167	15,000	4,400	23,000	81,000	....	....	....	47,300	......	......	26
6,618	292,720	560,763	489,636	602,239	....	....	303,829	2,218,376	......	......	27
334	6,610	8,648	4,000	109,960	....	61,412	....	10,000	......	......	28
319	24,975	145,165	26,000	253,100	....	....	....	....	......	......	29

An additional amount of completed manuscript of considerable magnitude has been delivered during the year to the Superintendent of the Census, for publication in the Census Report upon the statistics of the fisheries and fish trade of the United States, consisting of Parts V and VI of this report, as indicated in the analysis printed above.

15.—SUPPOSED DESTRUCTION OF THE TILEFISH.

Reference has been made in a preceding report to the phenomena connected with a wholesale destruction of the tilefish (*Lopholatilus chamæleonticeps*), an important food-fish recently brought to notice by the U. S. Fish Commission as occuring off the coast. The futile efforts to find even a few survivors were recorded in the report for 1882. A new attempt was made in 1883 by the Albatross, which proceeded to the ground and devoted several days to using a well-baited trawl and hand-line. She failed to meet with success, however, and for the present, at least, we must give up any expectation of renewing our acquaintance with the species. The search developed the remarkable fact that the associates of the tilefish, which were formerly found in great abundance at the same place, have either disappeared entirely or are represented by only an insignificant remnant. There is no theory that accounts for these phenomena satisfactorily, although it is suggested that it may have been due to an incursion of cold water from the arctic region or of warm water from the Gulf Stream. It is not unreasonable to presume that either of these conditions would produce an effect on fishes living in an intermediate temperature.

16.—THE POLE-FLOUNDER.

The pole-flounder, which was one of the most important discoveries made by the Commission in the earlier years of its work, continues to be met with over a wide range, occurring in a greater and greater depth as one proceeds southward. It is taken in almost every haul of the dredge, down to several hundreds of fathoms. As an article of food it is at least equal, if not superior, to any species of that family in the United States. The anomaly of its being so abundant, and yet never being taken except by the U. S. Fish Commission, is explained by the fact that it can be caught only by means of the trawl-net, the mouth of the fish being so small and weak as to prevent its swallowing a hook large enough to sustain its weight when hauled up. Connoisseurs in New York, to whom specimens were sent, pronounced it to be one of the best of American fishes, and in every respect equal to the far-famed sole.

17.—THE BLACK COD OF THE PACIFIC.

Among the fisheries of the United States of much promise in the future, but not yet developed, is that of the black cod (*Anoplopoma fimbria*), a species not in any way related to the true cod. It occurs along

the entire coast of California, Oregon, and Washington Territory, its extreme northern range not being determined. It is not much esteemed in its southern area of distribution, but in Washington Territory it is very highly prized, being much sought by the Indians. It lives in deep water, and can be caught on trawl-lines like the cod and halibut. We owe to Mr. James G. Swan, of Port Townsend, Wash., the first suggestion of the commercial and economical value of this fish for food purposes, and he informs us that the fish is eaten both fresh and salted. Several hundredweights of the salted fish were sent to the Commission by Mr. Swan, and these were treated, at the suggestion of Mr. Wilcox, by smoking, after which they were distributed to experts, who pronounced the fish to be one of the best known to them. Especial interest was excited among the fish dealers of Gloucester, Boston, and New York, and several expressed the intention of sending some one to Washington Territory for the purpose of effecting large catches of the fish for regular market treatment.

18.—NEW MODEL OF FISHING VESSEL.

As stated elsewhere, Captain Collins, a member of the Commission, is at present engaged in preparing the model of a fishing schooner to combine the best points of the American and British vessels, and made after studying the peculiar characters of both. It is proposed to ask from Congress the means to build after this model, and should it be generally followed, we may hope to witness a notable decrease in the loss of life and property. In 1883 Gloucester had a fleet approximating 400 fishing vessels, carrying from 4,300 to 4,800 men. About one-half to three-fourths of this fleet has been engaged in some branch of the winter fisheries, the rest of the vessels being hauled up about five months in the year.

In the ten years from 1874 to 1883 the total loss of vessels was 147, of which number 82 foundered at sea, 7 of the latter having been abandoned in a sinking condition. The total value of these vessels was $735,126. The total loss of life was 1,233 men, 895 of whom went down in their vessels, which foundered at sea. It is a little difficult to get at the exact number of bereaved families that lost their natural protectors, since for one or two years of the period under consideration accurate record was not kept of the widows and fatherless children left by these disasters at sea, and even if it had been it would not show how many almost helpless parents were deprived of their only means of support. As near as a correct estimate can be obtained, and this is probably an underestimate, 322 women were made widows and 658 children left fatherless by the disasters to the Gloucester fleet alone. Many of these families were left in utter destitution.

There can be but little doubt that upwards of 75 per cent of the vessels lost at sea meet with an untimely fate simply because they are too shallow; the consequence being that when caught in a gale they are

liable to be thrown on their beam ends, and, not being able to right because of their shallowness, fill and sink. In a single gale, that of December 9 and 10, 1876, no less than five Gloucester schooners were knocked down and barely escaped sinking. Three of them were dismasted, two of which were abandoned; one went into Liverpool, Nova Scotia, under a jury-rig; while the others were not so badly damaged. The inference is that other vessels that foundered in the same gale, and those that have been lost at sea on other occasions, were knocked down in a similar manner, and, failing to right again, soon sunk. Of course, with a deeper body to the vessels, and the ballast placed lower, there would be far less probability of such a mishap occurring, and even should it happen the chances would be a hundred to one that the vessel would right again. It is, therefore, altogether probable that the introduction of deeper fishing vessels in New England would save for Gloucester alone somewhere about $30,000 to $50,000 per year, besides a large number of lives.

As an instance showing how terrible the loss is sometimes, from the 29th of August to the last of December, 1883, 16 vessels from Gloucester foundered at sea, carrying down with them 205 men, while the loss of property was little less than $100,000.*

19.—FISHERIES OF THE GULF OF MEXICO.

One of the subjects to which it is proposed to direct the work of the steamer Albatross hereafter is the investigation of the fisheries of the Gulf of Mexico. These, which a few years ago were very prolific, are rapidly diminishing in number, so that all along the coast between the mouth of the Mississippi and Pensacola a much larger number of boats and vessels are required to secure only half the supply that was obtained a few years since. The reduction applies mainly to sheepshead, salt-water trout, redfish, mullet, gray-snapper, &c. The decrease of the red-snapper is not quite so marked, but it is probable that it will in time take place even more rapidly than the others, as it is particularly

* Mr. R. B. Forbes, on the same subject, says: "I have perused with great interest the statements on the subject of the loss of life among the fishermen of Gloucester. The loss of 447 vessels and 2,600 lives in fifty-four years ending in 1884 is fearful to contemplate. In twenty-two years ending this year the number of men lost was 2,140. There must be some cause for this large increase. It may be presumed that the increase of the number of vessels in the business accounts for the increased loss of lives in a great degree. Another cause must be the fact that the vessels are more crowded. Another prominent cause must be the fact that trawl-fishing in dories necessarily exposes the men to greater danger than hand-fishing. I have before me a long list of men who have been separated from their vessels; many of these have been lost, while some have been rescued in a starving condition. No regular rule has been established for furnishing dories with condensed food and means for cooking. This should be done. Mr. D. W. Low, of Gloucester, has contrived means not only to feed persons, but to enable them to right their dories and to cling to them when capsized. If the owners of fishing craft do not feel interest enough to encourage the use of these means, there should be a law to compel them to do so."

sought after by fishermen. The cause of the decrease is probably partly overfishing in particular localities, and partly the numerous pestilences and mortalities by which so many are exterminated. No satisfactory theory has been presented for this mortality, although an intelligent writer suggests that it is due to the influx of the cold water found near the sea bottom at great depth even in the Gulf Stream, which has the same effect as the northers on the coast of Texas during the winter-time.

20.—TREATY OF WASHINGTON.

The termination of that part of the treaty of Washington relating to the fisheries is attracting much attention on the part of fishermen; and the question is being mooted as to how this is likely to affect American interests, and what should be done by the United States in the way of renewal. A proper investigation of the subject can be had only after a careful study of the influence the twelve-year period has had upon the welfare of the American fishermen and the amount of the catch. The U. S. Fish Commission has for some time been engaged in securing the data necessary to consider the subject fairly and thoroughly, should it be brought before a commission such as sat at Halifax in 1877.

21.—COD GILL-NETS.

The importance of the introduction, by the U. S. Fish Commission, of the method of catching codfish by the use of gill-nets, has never been so apparent as during the winter of 1882–'83. Owing to the almost total failure of the bait supply it was impracticable to carry on the shore cod-fishery by the old method of hook-and-line fishing. Such a scarcity of bait was never known before, and if the fishermen had not been instructed in the use of gill-nets for the capture of cod a valuable and important industry must have been almost abandoned for the season, at least while the scarcity of fresh cod in our markets would have increased the price to such an extent as practically to place this important article of food beyond the reach of the masses.

But during the previous two years the New England fishermen learned a great deal about catching codfish in nets from an illustrated pamphlet containing descriptions of all the methods, which was freely circulated by the Commission, and to this was also added the knowledge gained in a practical way. They were therefore prepared to meet the emergency, as, instead of being compelled to give up the shore cod-fishery, they met with a success which has rarely or never been equaled. Such excellent results obtained by the use of gill-nets in the cod fisheries that the local papers in the principal fishing ports contained frequent notices of successful catches. The Cape Ann Advertiser of December 8, 1882, gives the following account of the "Good results of net cod-fishing."

"On Tuesday, December 4, boat Equal, with two men, took 5,000 pounds of large codfish in seven nets off shore, sharing $40 each. The

Rising Star has stocked $1,200 the past fortnight fishing in Ipswich Bay. The Morrill Boy has shared $101 to a man net-fishing off this shore the past three weeks."

The last mentioned schooner, the Morrill Boy, met with unexampled success, her crew of five men having shared $320 apiece, clear of all expenses, by the last of December, the time employed being less than six weeks.

From the port of Gloucester alone, according to Capt. S. J. Martin, there were employed in the gill-net cod-fishery during December twenty vessels, carrying one hundred and twenty-four men and one hundred and seventy-six nets. In the period between November 19 and the last of December, 600,000 pounds of large shore codfish were landed in Gloucester, while 150,000 pounds were marketed at Rockport and Portsmouth, making a total of 750,000 pounds. When to this is added the amount which was probably taken by the vessels from Swampscott, Portsmouth, and other ports, it is perhaps safe to say that no less than 2,000,000 pounds of this highly valued and most excellent food-fish were taken by nets during the month of December and the latter part of November. The fish caught in nets were of extraordinary size, averaging more than 20 pounds each, while some individuals weighed as much as 60 or 75 pounds.*

During the previous two winters cod were taken in nets, with rare exceptions, only in Ipswich Bay, but this season they were caught very extensively on the rocky shoals in Massachusetts Bay. Since the beginning of January, however, the fish were most abundant in Ipswich Bay, and the fleet of shore cod-fishermen resorted to that locality, where they met with the most encouraging success, the catch during the first month of the year being, it is said, much larger than at any previous time.† The Cape Ann Advertiser of January 26, 1883, contains the following item in relation to this subject:

"The net cod-fishermen are meeting with good success in Ipswich Bay. On Thursday of last week three fares of handsome large codfish, nearly 30,000 pounds, were landed at Portsmouth."

An important matter for consideration in this connection is that not only can the cod fishery be successfully carried on even when bait is

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* The above statements are based on the report of the Gloucester fisheries for November and December, by Capt. Stephen J. Martin, of the U. S. Fish Commission, pp. 159–161 of F. C. Bulletin, 1883.

† According to Captain Martin's report for January, 1883, 121,000 pounds of cod that were caught in gill-nets were landed in Gloucester during the month. Under date of February 6, 1883, he makes the statement that ten sail of small vessels, which had been fishing in Ipswich Bay, had landed at Rockport, Mass., and Portsmouth, N. H., during the previous twenty days, 230,000 pounds of large codfish. Calculating on this basis, the total catch of the whole fleet during the month of January would be very large. Owing to the fact, however, that no accurate and reliable statistics of the entire catch in gill-nets, along the whole coast, is obtainable, estimates must be based on the reports of the Gloucester fisheries, which have been carefully made by Captain Martin.

not obtainable—for, of course no bait is required when nets are used—but a very great saving is made in time and expense. As an instance of this it may be stated that the average bait-bill of a shore trawler would be not less than $150 to $250 per month when herring are so high-priced as they were this winter. Therefore it is safe to estimate that, when such a large fleet is employed in gill-netting as there was this season, the amount saved to the fishermen (which otherwise must be paid for bait) cannot be less than $30,000 to $40,000.

The day is now not far distant when the U. S. Fish Commission will be able to supplement what it has done, by propagating the cod on a very extensive scale, this having been found perfectly practicable.

C.—THE INCREASE OF FOOD-FISHES.

22.—BY PROTECTIVE MEASURES.

The question of the proper measure of protection to be given to fish, with a view of preventing their destruction or of securing their increase, is one that has occupied much attention during the past few years. The uncertainty as to whether the United States or the States themselves should enact the necessary legislation has in many cases prevented definite action.

Reference has already been made to the investigations of the Senate committee on fisheries in regard to the amount of protection to be given to the menhaden and bluefish, and the report of this body when issued will doubtless contain much that will be of great importance in the ultimate solution of the problem.

The subject of protection in the Great Lakes is also one that has been recently mooted by various legislatures and conventions, the question being somewhat complicated by the fact that a foreign nation for the most part owns the opposite shores, and that the question of the jurisdiction of the United States as against that of the States separately being, as already mentioned, still unsettled. There are thus three parties in the field, all of whom have to be considered in the inquiry.

Numerous complaints have reached the Commission in regard to the wasteful methods of capture, which seriously interfere with the proper maturing of the many young fish introduced into the lakes by the several States and the United States. These fish, only half grown, are said to be taken by the ton. The remedy suggested is to prohibit the use of any net of a mesh less than $4\frac{3}{4}$ or $4\frac{7}{8}$ inches. It is also suggested that the depth of water in which fishing should be carried on during the spawning season should be regulated.

The lake trout is also a sufferer by wasteful methods of capture; and it is sometimes taken in such quantities as to supply much more than the demand.

A meeting of fish commissioners of States bordering on the Great

Lakes was held at Detroit, October 17 and 18, 1883, to confer upon a better protection of the lake fisheries, uniform laws, artificial propagation, relation of the State commissions to the United States Commission, and the fishery authorities of Canada.

The United States Commission was represented by Mr. Frank N. Clark, who reported an interesting meeting. The following resolution was passed and transmitted to the U. S. Fish Commission:

"*Resolved*, That this conference recommend and respectfully request the fish commissions of the different States bordering on the Great Lakes to urge upon their several senators and congressmen the advisability of securing some action by the United States Government, through the instrumentality of the U. S. Fish Commission, to induce the Commission to send one of its steamers with a sufficient force of scientific men to the Great Lakes, for the purpose of investigating the habits of the fish natural to those waters, the method of fishing pursued therein, and all other matters connected with the fishing industries."

23.—BY THE USE OF FISHWAYS.

Fishway over the Great Falls.—Reference has been made to this work in the previous report. Since then the surveys of the Great Falls have been completed, and a site has been selected for the construction of a suitable fishway which will enable shad, striped bass, and other food-fishes to ascend to the upper portion of the Potomac.

After careful consideration of the different varieties of construction offered, a plan of fishway suggested by Colonel McDonald has been adopted, and he has been instructed to have prepared the necessary working drawings for the purpose, to be submitted to contractors for estimates. Should this be within the appropriation, it will be recommended to the Secretary of War for such further action as he may think proper.

The early history of this fishway will be found in the report for 1882.

24.—BY THE DISTRIBUTION OF FISH AND EGGS.

As already explained in a previous part of the report, the method of distribution of fish and eggs has been almost entirely changed from service by means of messengers using the baggage cars of passenger trains, to the employment of cars built or fitted by the Commission expressly for the purpose. A great economy of service has been the result; and where a shipment of ten thousand was formerly possible, millions can now be sent. The work has been mainly under the direction of Colonel McDonald, to whose report in the appendix reference should be made for details. It may be stated, however, that the total number of applications for fish during the year was 10,060. These were mostly for carp. The actual distributions were, in brief, as follows:

Carp.—The total number of carp distributed during the year was 162,000 to 7,015 applicants. These were situated in every State and Territory, 292 congressional districts and 1,308 counties being repre-

sented. The distribution was made during the months of November and December, as being those in which fish can be transported with less danger of injury.

Shad.—The number of shad sent to a distance during the year amounted to 12,408,000, together with about half that number of herring.

Whitefish.—The distribution of the whitefish obtained from eggs taken in 1883, was made for the most part from February to May of the following year; one of the cars being constantly employed during that period in transporting them from the hatchery at Northville, to a suitable point on the lakes. About 49,000,000 fish were thus transferred. The most prominent places of deposit in the Great Lakes were Manistee, Grand Haven, Traverse City, Port Huron, Ludington, Fort Gratiot, and Escanaba, in Michigan; Racine, Milwaukee, Sheboygan, and Ashland, in Wisconsin; North Bass Island, Put-in-Bay Island, and Ottawa City, in Ohio; and Erie in Pennsylvania; while a large number were planted in some interior waters of different States, either directly or through the State fish commissioners.

Of other members of the salmon family an extensive distribution was also made, the details of which will be found in the several special reports. The eggs of these were obtained from Grand Lake Stream and Bucksport in Maine, the trout ponds on the McCloud River, California, and at Northville, Mich., and Wytheville, Va.

25.—SPECIES OF FISH CULTIVATED AND DISTRIBUTED IN 1883.

a. The codfish (*Gadus morrhua*).
b. The Spanish mackerel (*Scomberomorus maculatus*).
c. The rockfish or striped bass (*Roccus lineatus*).
d. The mullets (*Mugil*).
e. The whitefish (*Coregonus clupeiformis*).
f. The brook trout (*Salvelinus fontinalis*).
g. The lake trout (*Salvelinus namaycush*).
h. The saibling (*Salmo salvelinus*).
i. The California, rainbow, or mountain trout (*Salmo irideus*).
j. The Atlantic or Penobscot salmon (*Salmo salar*).
k. The Schoodic or landlocked salmon (*Salmo salar* subsp. *sebago*).
l. The European trout (*Salmo fario*).
m. The quinnat or California salmon (*Oncorhynchus chouicha*).
n. The shad (*Clupea sapidissima*).
o. The carp (*Cyprinus carpio*).
p. The goldfish (*Carassius auratus*).
q. The golden ide or orf (*Leuciscus idus*).
r. The tench (*Tinca vulgaris*).
s. The catfish (*Amiurus*).
t. The clams.
u. The American lobster (*Homarus americanus*).
v. The oyster (*Ostrea virginica*).

a. **The Codfish** (*Gadus morrhua*).

The Fulton Market (*New York City*) *Station.*—As referred to in previous reports, a renewed effort was made to utilize the live spawning codfish brought in during the winter season to Fulton Market, the necessary facilities in the way of a station being furnished by Mr. E. G. Blackford, fish commissioner of New York. The work was begun on January 8, and by the 11th 4,000,000 sound eggs were obtained. A reasonable number of these were hatched out and deposited, but further operations for the winter were prevented in consequence of the destruction of the adult fish by slush ice in the East River. Mr. S. I. Kimball, Superintendent of the Life-Saving Service, on application of the Commission, kindly ordered the crew of the life-saving stations on Long Island to assist in collecting eggs of cod should they be procurable.

On a previous page reference has been made to the continued life history of the school of cod hatched out at Gloucester in 1878–'79. It is not improbable that the fish first hatched out have reproduced their kind, as young gray cod of two sizes are now taken during the summer on the coast. In 1882 they were abundant off Portsmouth, N. H., the fishermen being satisfied that they were the result of the work of the Commission. During the summer of 1883 numbers were taken in the mouth of Gloucester Harbor, one man capturing 70 or 80 pounds on a mackerel line, the fish weighing from half a pound to 2½ pounds each. It would seem from these statements that not only have these fish been successfully planted, but also that they have changed their habits and are likely to continue to be an inshore summer fish, which is of course a desideratum of very great importance. A note given below from Mr. R. S. Tarr, an intelligent naturalist and resident of Gloucester, contains further information on this subject.*

* While in Gloucester recently I made some inquiries in regard to the report that small cod of the species *Gadus morrhua* were very abundant in the harbor. Although I was there in the wrong season, still I think that I gained enough information to establish beyond a doubt that small cod, some as large as 14 inches in length, belonging to *G. morrhua*, are extremely abundant at Gloucester; and as these belong to the species which is at present almost entirely deep-sea, it seems evident that we must look to some other causes than natural ones to explain the appearance of such great numbers in so small an area, for as far as I can find out only one other school has been seen along the New England coast in shallow water. I talked with several fishermen, and they all reported the abundance of the "silver-gray cod," which could not be distinguished by them from the deep-sea cod. The most intelligent and observing of all with whom I spoke was Mr. Edwin F. Parsons, of East Gloucester, who expressed a willingness to correspond with you upon the subject, and also to make preparations of specimens, under your direction, if you desired it.

He told me that in the spring and summer for the two past seasons, while fishing for bait for his lobster traps, he took great numbers just outside of Ten-Pound Island. Their abundance dwindled down until in February they were least abundant. Last spring the largest fish weighed 4 or 5 pounds, and often in a day 100 pounds would be the result of his catch. He did not fish especially for these, but simply for bait for his traps. The cod he would sell, while the other fish would serve his purpose. He thinks that he can see three generations, the largest weighing 5 pounds and the

b. **The Spanish Mackerel** (*Scomberomorus maculatus*).

The Fish Hawk Station.—An effort was made during the present summer to hatch eggs of the Spanish mackerel in the Chesapeake Bay on board the steamer Fish Hawk, under the command of Lieut. W. M. Wood. The vessel was occupied in the work from June 21 to August 15, the first ripe spawn being obtained at Mobjack Bay on the first-mentioned date. During the month of July the fishermen were very successful with their nets in taking fish, but it was found difficult to obtain ripe eggs among them. In all, 6,500,000 eggs were taken in June and July and placed in the cones for hatching. The result was, however, in every instance a loss of the eggs, except on July 4th, 250,000 hatched and were returned to the water. Lieutenant Wood, in his report in the appendix, has given an account of the efforts made, and, together with Dr. Kite, has described the apparatus made use of for hatching.

c. **The Rockfish or Striped Bass** (*Roccus lineatus*).

In view of the rapid decrease in the abundance and size of striped

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others considerably smaller. Although he has been fishing for seven or eight years, never before 1882 did he find deep-sea cod in any numbers inside of Gloucester Harbor. Taking into account this fact, Mr. Parsons feels confident that they can be no other than the fish put into the harbor in 1879; and he wished me to say that he feels thankful for the money he had made and the chowders he has had, as he expressed it, at the expense of the Fish Commission. Considerable enthusiasm is expressed among the fishermen in regard to this matter, and they feel anxious that the work started in 1878 shall be continued. Not only are these fish caught in the outer harbor, but even in the innermost docks of the inner harbor, boys, while fishing for flounders, frequently land gray cod. This is extremely remarkable—that such cod should be found in the very impure water of the docks. But still this is asserted by many. My cousin, Mr. Spinney, who for many years was a practical fisherman and a good observer, and now the head of a firm which handles thousands of cod every month, has examined them critically and compared them with deep-sea cod, and said positively that they were the same. The specimen sent by Mr. Wonson is *G. morrhua.* If you wish specimens in alcohol, Mr. Spinney will obtain any that you want upon receiving directions from you. Mr. Spinney sees nearly all the cod which enter Gloucester, and upon being asked if the gray cod was found at other points along the coast he said that the only instance that he knew of was the case of a vessel which had just landed 15 barrels of cod taken in shallow water near Mount Desert. I went to the wharf and found the fish, which proved to be *morrhua*, 14 inches long. I obtained two specimens for the National Museum. They seemed to run about the same size, varying about 1 inch in length, and correspond in size almost exactly with the specimens taken at Gloucester. These may be a portion of the cod from Gloucester emigrating from their original home. As this was the only case which I could find of the *G. morrhua* being found in shallow water, outside of Gloucester, I am inclined to the opinion that they are but an offshoot of the Gloucester cod.

Another recognized good caused by the Fish Commission while at Gloucester is in regard to the reddening of fish. I was informed by several fish-dealers who have adopted your suggestion to use Trepani salt instead of Cadiz, that not a single instance of reddening has occurred during the past summer. The butts used for pickling the fish exhibited a tendency to turn red only when they had previously been saturated with Cadiz salt.

WASHINGTON, D. C., *November* 12, 1883.

bass on the coast the Fish Commission has been desirous of increasing the supply by artificial propagation, but the difficulty of finding the ripe parent fish has hitherto been a barrier in the way. At the request of the Commission Mr. S. G. Worth, superintendent of fisheries of North Carolina, made some experiments at Weldon, in that State, and found that it was practicable to secure quite a number of the breeding fish. He hatched out many of them successfully, and obtained data enough to warrant the hope that the work might be done on a much larger and more efficient scale hereafter.

In June, 1882, as previously recorded, with a view of determining whether the rockfish or striped bass could be kept in pens until their eggs should ripen, a large number were placed in the pool at Battery Station, near Havre de Grace. No fish larger than 8 pounds were secured, so no results were obtained. Some of them, however, lived into the summer of 1883, but as they were not adult, and no effort was made to feed them they were found to be in poor condition.

It may be remembered that several years ago the fish commissioners of California secured the services of Mr. Livingston Stone to transport a number of young striped bass to California waters. Since then report has been made of captures of these fish, one of them on November 7, at San Francisco, weighing 17 pounds.

d. **The Mullets** (*Mugil*).

Several species of this genus occur very abundantly on the southern coast, so much so, indeed, as to constitute a special fishery; but nothing has been done in regard to introducing them to other waters. They are found in small numbers eastward, Vineyard Sound being perhaps the limit of their occurrence in that direction. Here, however, they are small and of no commercial value. Some species thrive in fresh water. The experiment has been made by the California fish commissioners of transporting a Sandwich Island species into that State, although I have no report as to the general result. This fish is propagated in the harbor of Honolulu, being reared in artificial ponds made in the salt marsh lands near that city, and large quantities are obtained there for the market. They are much esteemed as an article of food, and the subject is one that will be deserving of future consideration.

e. **The Whitefish** (*Coregonus clupeiformis*).

The Northville Station.—The anticipations excited by the great success of this station in previous years were fully met during 1883, under the continued supervision of Mr. Frank N. Clark. Perhaps the most important improvement this year in the arrangements for hatching consisted in the introduction of the McDonald jars, which proved an entire success and suited to the enlarged operations of the station. The water supply was thought not to be sufficient for increasing the old method of service, but the economy of these jars, which permitted the water to be used over and over, rendered the fears groundless. The

first instalment of whitefish eggs was received November 14 from Lake Erie, and the last was received December 1. A heavy storm in the middle of November made it necessary to abandon Lake Erie, and the bulk of the eggs was obtained from Lake Huron, the principal places being at the mouth of Thunder Bay. Some very heavy catches of whitefish were made on the Canada side around Duck Island, one propeller having on board 45 tons of whitefish at a single time. These whitefish were large, specimens weighing from 15 to 20 pounds being frequently taken, and the largest weighing 26 pounds. The experiment of holding adult whitefish in inclosures until the eggs were ripe was renewed, and proved as successful as it had been during the previous years. The fish were kept in floating crates at North Bass Island, in Lake Erie, and at Alcona, in Lake Huron. The crates were anchored about 20 rods from the beach, in 12 feet of water. From the fish confined therein 5,000,000 eggs were taken, and not a fish died while confined in the crates.

During the season 25,000,000 eggs were brought from the fisheries direct to Northville. There were transferred from the Alpena Station 35,000,000 eggs, making a total of 60,000,000 handled at this station. Of this number 12,000,000 were sent away and 8,000,000 were lost in various ways, the total number hatched at this station being 40,000,000. Of the 12,000,000 eggs which were removed 1,000,000 were sent to Germany, 1,000,000 to New Zealand, and the remainder to State and national hatcheries. Those sent to foreign countries reached their destinations in good condition; those for New Zealand having been received at San Francisco and forwarded by Mr. R. G. Creighton, and those for Germany having been repacked and forwarded from New York by Mr. Fred Mather.

The young whitefish began to hatch out on the 16th of February. On the 20th, car No. 2, in charge of Mr. Ellis, was loaded with 3,000,000 eggs to be taken to Manistee. The car made trips back and forth from the Great Lakes until all were disposed of.

Quite extensive operations were prosecuted at this station in brook trout, lake trout, rainbow trout, and German trout, which will be treated under their proper heads.

The Alpena Station.—This station was supplied with both the McDonald and Chase jars, and the water supply obtained from the city waterworks. Not being, however, upon a railroad it was necessary to transfer 35,000,000 of eggs to the Northville hatchery in order to avoid moving live fish. The supply of eggs which was derived from 68 pound-nets and numerous gill-nets, filled 375 jars. Of these 32,000,000 were hatched at Alpena, and the remainder sent to Northville. The fry hatched at Alpena were planted mostly on the west coast of Lake Huron in April, 1884.

The question has arisen as to whether it is better to deposit the young fry of whitefish and other salmonidæ in distant waters, as soon as the

yelk bag is absorbed, or to keep them until they have attained considerable size, and can better protect themselves against their enemies. When, however, fish are cultivated on the scale adopted by the Fish Commission, it is almost impossible to find the necessary inclosures where they would have sufficient room, or to supply the food that they would consume. For if 100 fish would devour an ounce of food each day, 1,000,000 would consume about 600 pounds, or 108,000 pounds in six months. The estimate in this case is probably much below the actual figures.

Another point is as to the length of time it should take to hatch out the eggs, whether it would be better to use warm water from springs to accelerate this result or to retard it by applying the colder water of the lakes. This question has not yet been satisfactorily decided, the action of the fish commissioners of the States varying in this respect.

f. **The Brook Trout** (*Salvelinus fontinalis*).

The Northville Station.—During the season between October 10 and November 21, there were taken from the creeks near the hatchery 200 brook trout, of which 33 were found to be ripe females, and which yielded 18,000 eggs.

There were in the station some 10,000 fry, 2,000 yearlings, 500 two-year-old trout, and 500 three and four-year-olds. From these fish a large number of eggs were taken. Of these, 25,000 were sent to Germany, 150,000 to Washington, and smaller numbers to various State hatcheries. The eggs taken from the wild trout were hatched, and the fry returned to the streams.

Ten thousand trout eggs from the 1882 stock were forwarded, January 13, to E. G. Blackford for transmission to Bogota, U. S. of Colombia.

g. **The Lake Trout** (*Salvelinus namaycush*).

The Northville station.—A large number of lake trout were captured in Lake Erie, the best days being early in November. The fish spawned this season much later than usual. Although no eggs were taken after November 18, a good many fish were reported as yet unripe. There were 280,000 eggs taken, of which 25,000 were sent to Germany and 100,000 to Washington. There were also 105,000 eggs at Northville, and the young distributed by car No. 2 to Strawberry Lake, Star Lake, and Crooked Lake, in Northern Michigan. The remainder were deposited in Arnold's Lake, in Washtenaw County.

The lake trout promises to be an important inhabitant of cool lakes, and even of flowing streams. The young exchanged with fish-culturists in France and Germany have succeeded very well, and give great satisfaction. Numerous letters are on file in the office of the Commission making grateful acknowledgment of the favor.

h. **The Saibling** (*Salmo salvelinus*).

Among the most highly esteemed species of the trout family of Europe is the saibling, known in England as char and in France as *ombre*

chevalier. Through the courtesy of the president of the *Deutsche Fischerei-Verein* a number of the eggs were received in January, 1881, and sent to the fish commissioners of New Hampshire, at Plymouth, for development. They proved hardy and grew satisfactorily, and on December 3 of the present year about 600 eggs were taken by Commissioner Hodge. These will be transferred to another station, to be hatched and reared; and it is hoped that the species may in time become well known in this country. The fish is specially adapted to the deep waters of cold lakes, being very abundant in the Geneva and other lakes of Switzerland.

i. **The California, Rainbow, or Mountain Trout** (*Salmo irideus*).

The McCloud River Station.—The season for taking trout eggs opened on January 3 and continued until the 5th of April, when it was found that from over 33 spawning females 386,000 eggs had been taken. Mr. Loren W. Green was more particularly in charge of this station, although Mr. Stone retained the general supervision, and the latter states that Mr. Green is entitled to great credit for the endurance and perseverance exhibited in his work.

Each year a number of parent trout are taken from the river for the purpose of replenishing the trout ponds and to make up for the yearly losses sustained. This season, for the first time, several thousand young trout were reserved in the hatching troughs, and, later, 12,000 were placed in a pond by themselves to be reared for breeders. This necessitated some new ponds, which were built during the year. In order to help maintain the supply 20,000 fry were turned loose in the river. Of eggs there were lost during the various operations but 24,000, and the remainder, 332,000, were forwarded to Washington and various State hatcheries. For further details of the work reference may be made to the report of Mr. Stone in the appendix, where will be found some interesting remarks upon the abundance of panthers, wild-cats, lynxes, raccoons, minks, otters, and other frequenters of the region.

The Northville Station.—It has been found that since the rainbow trout were brought from California to this station their habits have so far changed that they have become winter spawners. Mr. Clark believes that in a few years they will spawn simultaneously with the brook trout. In January and February he took 125,000 eggs, but only succeeded in fertilizing one-fourth of them. He shipped 12,000 eggs to Mr. Mather for Germany, 3,000 for France, and 3,000 for England. He hatched 10,000 fry, which were planted in Indiana, Michigan, and Ohio. There was also received a case of 4,000 rainbow-trout eggs on March 18 from the McCloud River station. These arrived in prime condition, and the fry which were hatched from them were added to the breeding stock. Two new trout ponds were completed in June of the present year.

The introduction of the California trout to Eastern waters was first

made in a practical manner by the New York fish commission, its well-known superintendent, Mr. Seth Green, having brought a number from the McCloud River to the State hatchery at Caledonia, from which to obtain eggs for distribution in various waters in the State of New York. Subsequently the U. S. Fish Commission established the ponds on the McCloud River, of which such frequent mention has been made in previous reports. The rapid growth and game qualities of this fish, and its adaptation to many waters where the brook trout will not thrive, have caused the great demand which it is not easy to supply, but which the Fish Commission is now endeavoring to meet as far as possible. Reports from various quarters on this fish are very satisfactory. By planting them in public waters they are likely to extend over a wide area, and furnish to all an opportunity for capturing them. A specimen caught in the free water of the Roanoke River of Virginia weighed about 10 ounces. It was the product of an egg hatched about two years before.

j. The Atlantic or Penobscot Salmon (*Salmo salar*).

The Bucksport Station.—Mr. Charles G. Atkins continues in charge of this station, and, as heretofore, the operations were conducted jointly by the United States and the Maine and Massachusetts Fish Commissions. As heretofore, the breeding salmon were purchased from the Penobscot River fishermen. There were secured 431, which averaged 18 pounds in weight, this being about 5 pounds heavier than the average of the previous year. It was found, however, that the large salmon were much more susceptible to injury from handling than smaller ones, so that of the 431 purchased but 267 reached the breeding ponds. There was an unusual proportion of female fish, and, as already indicated, they were of extraordinary size. Consequently the spawning operations which lasted from October 29 to November 7 resulted in the taking of 2,535,000 eggs, an average of 12,000 to the fish. Prior to shipment between 4 and 5 per cent were found defective, leaving 2,420,000 sound eggs. A pro rata division of these gave to the United States 1,370,000, to Maine 700,000, and to Massachusetts 750,000. From the United States quota 500,000 eggs were sent to the Cold Spring Harbor Hatchery, which were incubated with very slight loss, and were planted in several New York streams. Of the 100,000 sent to Wytheville, 50,000 were hatched and planted in the Oswego River, and the remainder were retained at the hatchery. From the Maine quota large deposits were made in the Androscoggin River, Crooked River, Webb's River, Sandy River, Piscataway River, Mattawamkeag River, and the Denny's River. Thirty thousand were sent to Northville.

The Northville Station.—On February 28, a case of 30,000 Penobscot salmon eggs was received from Bucksport, Me., which on being unpacked, were found in good condition. The fish hatched out between March 16 and March 24. the loss being but about 600. Over 29,000

were planted on May 25 in the headwaters on the Huron River, in Oakland County, Michigan.

k. **The Schoodic or landlocked Salmon** (*Salmo salar* subsp. *sebago*).

The Grand Lake Stream Station.—This station, which continues in charge of Mr. Charles G. Atkins, was eminently successful during 1883. During the fishing season which existed from October 29 to November 20 there were taken only 1,005 fish, of which 709 were females and 296 males. As with the salmon, however, they proved to be large and prolific. From the 661 females found to be ripe 1,070,500 eggs were secured, an average of 1,623 to each female. The heaviest female weighed 8.8 pounds, and the heaviest male 5.4 pounds. The new hatchery, which was erected in 1882, proved very useful, and the eggs taken were divided between the two hatcheries, the one fed by spring water and the other by lake water. After the removal of the unfertilized and other imperfect eggs, there remained 960,000 for use. Of these 240,000 were set aside as a reserve, 373,000 assigned to the United States, 133,500 to Maine,133,500 to Massachusetts, and 80,000 to New Hampshire, this being in proportion to the funds contributed by each.

From the United States quota, 5,000 eggs were sent to New York, and forwarded by Mr. Fred Mather, by the steamer Baltic, to Sir James G. Maitland, Stirling, Scotland. The remainder of the United States lot was assigned to State commissioners, some thirteen different States sharing in the distribution. In general, these eggs reached their destination in good order, and were successfully hatched and deposited in suitable waters, the full details of which will be found in a table appended to Mr. Atkins's report.

It has so far proved almost impossible to meet the call for eggs or young of this fish.

l. **The European Trout** (*Salmo fario*).

Eggs of this species were received from Mr. Von Behr, the president of the *Deutsche Fischerei-Verein*, in the winter of 1882–'83, and were sent directly from New York to the station at Northville, where they arrived on February 18. The eggs were successfully hatched out by Mr. Clark by the middle of March, and early in April were planted by him in a branch of the Pere Marquette River of Northern Michigan.

The European trout is an excellent table fish, and attains a much larger growth than the species found in the United States, a weight of from 10 to 20 pounds being not unusual. It is hoped that it may be available for some localities not so well fitted for the brook trout, where, by its rapid growth and the size to which it attains, it may constitute an important article of food.

m. **The Quinnat or California Salmon** (*Oncorhynchus chouicha*).

The McCloud River Station.—An unprecedented and unforeseen condition of things was experienced at this station during the present

year. The hatchery was put in order at the usual time, and an annex 80 feet long by 8 feet wide was built for the purpose of accommodating an additional 2,000,000 salmon eggs for the California commission. When the time came for salmon to arrive, few if any were to be found. Mr. Livingston Stone, who is still in charge of this station, arrived at the station August 1, and on the 7th of August, when it was expected that 500 or 1,000 salmon would be taken, but one specimen, and that a small one, was caught. As the days passed on the numbers continued very small; and it was not possible to secure during the latter time more than 1,000,000 eggs, and a careful investigation was made of the cause of the scarcity. It was found that from 3,000 to 6,000 Chinamen were at work on the California and Oregon Railroad, which runs along the Sacramento River, 8 or 10 miles below the hatchery. The blasting operations of the railroad company were on a gigantic scale, it being stated on good authority that two six-horse wagon loads of gunpowder were used at a single blast, and that this blasting was kept up day and night. Mr. Stone considers this blasting to be an ample explanation of the failure of the salmon to ascend the river. But it was also alleged, with some show of truth, that the Chinamen did a very large business in capturing fish below, while they were at work, by exploding giant powder in the river. As before stated, but 1,000,000 eggs could be obtained. These were handled with great care, but on the 19th of September an accident happened to the wheel, which cut-off the supply of water, and 25 per cent of the eggs were lost before the necessary changes could be made. The remainder were turned over to the California fish commission on the 6th of October, to be hatched and returned to California waters.

In addition to the scarcity of salmon in the McCloud, which was attributed to the operations on the railroad, it was discovered that there were very few salmon in the Spokane River. This was the cause of considerable consternation to the Indians who annually encamped near Spokane Falls in anticipation of a large run. Up to October 1, they had obtained not more than a few dozen fish, while in 1882, a traveler reported seeing from 40,000 to 50,000 salmon drying at one time under the care of the Indians.

The catch of salmon at the canneries on the Sacramento River was fully up to that of the previous year. The total for the year ending October 15, 1883, was stated to be 451,957 spring salmon and 160,542 fall salmon, weighing 7,349,988 pounds, delivered to the different fishing firms. The wholesale dealers received 115,004 spring salmon and 52,902 fall salmon, making a grand total of 780,405 salmon, weighing 9,585,672 pounds.

The average yield of the canneries on the Sacramento for the years 1881, 1882, and 1883 was 9,596,984 pounds. The average yield for 1875 and 1876, before any fruits of fish-culture could have appeared, was 5,205,102 pounds, a net gain per annum of 4,391,882 pounds.

A small consignment of salmon eggs, for experimental purposes, was forwarded from California to Washington by express, arriving October 4. The long time they had been on the way, with perhaps insufficient care in transit, caused the loss of the entire lot from overheating.

n. **The Shad** (*Clupea sapidissima*).

With a view of ascertaining what could be done in the southern waters in the way of hatching shad, Mr. Ferguson started on board the steamer Lookout, and arrived at the mouth of the Saint Mary's March 20, from which point he proceeded to the Saint Mary's River and made a careful examination of it as far as Clark's Bluff, a distance of 30 miles. At this point the nets of Mr. Pierson were being fished with a result on the average of 100 shad per day, several ripe ones being found among them. Having ascertained that good hatching work could be done on this river, the Lookout next proceeded to the Saint John's River, which was reached on the 22d of March. On the way to Jacksonville many gill-nets set for shad were observed, but there was a complaint of the scarcity of fish. Yellow Bluff, a small settlement below Jacksonville, was found to be the center of the shad fishing on the Saint John's River. At Jacksonville the shad in the market appeared to be about a week or ten days from maturity. From Jacksonville the steamer proceeded to Palatka and Lake Monroe, where small shad-fisheries were found. Returning on the 27th, the vessel left Jacksonville on the 28th, and after a stop at Saint Augustine arrived in Washington April 19. For successful work on the Saint Mary's it was decided that everything should be in readiness for operations by the 1st of March.

During this season the following stations have been occupied for the purpose of hatching shad and herring on the Potomac and Susquehanna: (1) Quantico and Glymont by the Fish Hawk; (2) Fort Washington for collecting the eggs; (3) Central Station for hatching eggs brought from the river; (4) Battery Station, Havre de Grace.

Quantico Station.—Having taken on board the usual shad-hatching outfit the Fish Hawk, under Lieutenant Wood, left the navy-yard, April 12, for the mouth of Quantico Creek, for the purpose of establishing a station for hatching eggs of shad, herring, perch, &c. On the next day Lieutenant Wood visited the fisheries within reach, and found that Budd's Ferry was not being fished at all; that Stump Neck fishery would begin shortly; that the Freestone Point fishery was in full operation and doing well, 400 and 600 shad having been caught in two hauls that day, as well as 10,000 herring. The fish, however, were found to be unripe, and the temperature of the water 60°. There were taken, however, that day 50,000 eggs from a herring. On the 24th of April Lieutenant Wood reported, that owing to a protracted rain, the temperature had fallen to 50, and had completely arrested the development of the eggs in the cones. Young herring, estimated at 600,000 in number, were put in the river that day (the change of temperature killed about

7,000,000 others). The water continued cold, and very little being accomplished, the vessel was moved higher up the river, to Glymont, May 7, where it was continuously engaged until the 28th of May, when it returned to the navy-yard. On the 8th of May Lieutenant Wood reported having taken 12,000,000 eggs of herring, 60,000 of perch, and 7,000 of shad.

Fort Washington Station.—This station was placed in charge of Lieut. William C. Babcock, U. S. Navy, and the Secretary of War having given the desired permission to occupy the grounds and buildings, the work began April 14. Some difficulty was found in inducing the fishermen to co-operate. Mr. L. G. Harron was permitted to fish the Fort Washington shore on condition of supplying eggs to the Commission. The fishing shores of Moxley's and Brant's Points, Ferry Landing, and White House were visited regularly during the season, which on the whole was a bad one, being interrupted by rains and change of temperature of the water. Lieutenant Babcock, however, was able to obtain 21,850,000 eggs. The first eggs, 64,000 in number, were taken April 14. The greatest number of any one day (1,140,000) were taken May 19. On the 21st of May Mr. Harron violated his contract and withdrew his seine, when it became necessary for the Commission to put its own net into the water and to haul it during the remainder of the season. This was done very successfully, and a larger average of shad were taken in it than had been taken in Mr. Harron's seine. The last eggs taken during the season were 15,000, June 10, when seining was discontinued; and on the 13th all of the eggs were transferred to Central Station, as during the early portion of the season the river steamers were depended upon for transportation. After the 8th of May the Lookout was at the disposition of Lieutenant Babcock, and enabled him to turn the eggs over much more promptly to be hatched. Lieutenant Babcock was assisted by Mr. John Lucket, in charge of the seine, and by Mr. James Carswell, who had immediate charge of the spawn-takers. His report will be found in the appendix.

Central Station.—This station was used for hatching the eggs sent up from Fort Washington. The young fish when ready for shipment were transferred directly from the hatching apparatus to the cars. This was great saving of time and of risk and expense of removal by wagons.

Battery Island Station.—The arrangement of the grounds, buildings, and other improvements made at this island for the purpose of utilizing the extensive fisheries in the vicinity, were quite fully described in the report for 1882.

The management of this station for 1883 was placed in charge of Lieut. W. F. Low, U. S. N., who was furnished with a seine 906 fathoms in length, to be operated by steam, and a force of 30 men. On the 19th of April the first shad eggs, 25,000, were secured, and other were obtained on the following day. From the 22d to the 27th of April it was impossible to accomplish anything; after that, however,

eggs were obtained daily, during the remainder of the season. The shad caught, if not ripe enough for spawning purposes, were placed in a large pool or reservoir until they became so, and were then caught and stripped. On the 12th of May, Mr. Frank N. Clark, of Northville, visited this station for the purpose of observing particularly the effects upon the shad of their being penned during this stage. His report will be found in the appendix. His experiments appended show that the female shad is extremely sensitive to the least interference with its method of reproduction; and that under certain circumstances injuries will result. Some of the shad with roe particularly affected as the result of confinement in the pool were sent to Mr. John A. Ryder, at Washington, the biologist of the Commission. He discovered certain abnormal appearances with a peculiar tendency toward fluidity. He decided that impregnating such ova would be out of the question.

On the 4th of June, Lieutenant Low was relieved from duty at this station, and Mr. Frank N. Clark placed in charge thereof. Lieutenant Low had collected 6,363,500 eggs, had deposited in local waters 3,751,500 fish, and delivered to be distributed by the Fish Commission messengers 1,633,000 fish.

From June 4th to June 8th Mr. Clark collected 1,096,000 eggs, from which there were hatched 768,500 fish, of which 521,500 fish were planted in the bay, and the rest delivered to the Fish Commission messengers.*

A pamphlet of three pages, entitled "Inducements offered fishermen to furnish shad eggs for the U. S. Commission of Fish and Fisheries," prepared by Lieutenant Babcock, was issued to shad fishermen during the season. In this, full instructions were given for stripping shad and caring for the eggs. It was also stated that the necessary apparatus would be furnished upon application to the Armory building in Washington and on board the steamers, and that a liberal price would be paid to the gillers, pound-net, and seine fishermen for eggs taken according to the instructions and delivered on board the steamers of the Commission as they made their daily trips. The instructions were also published in the Bulletin of the Fish Commission, vol. ii, page 389.

This season the experiment of shipping shad eggs by express on trays covered with wet cloths was first tried by Colonel McDonald. A lot of eggs thus sent to S. G. Worth, Raleigh, N. C., reached their destination in excellent condition.

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*The shad fisheries of Havre de Grace in 1883 were reported to have given occupation to 259 men, 6 engines, and 15 horses, using 4,217 fathoms of seine. The number of shad taken was 46,967. These were sold mostly in Philadelphia, the Baltimore market being supplied by day fishermen. In addition to the shad which were seined, 16,500 were caught in gill-nets, making a total for Havre de Grace of 62,967 shad. The statistics of all the fisheries of the Susquehanna and at the mouth of the Chesapeake, could they have been obtained, would probably have shown a total catch of 100,000 shad for the season.

o. **The Carp** (*Cyprinus carpio*).

The work connected with the carp may be considered among the most important of the operations of the Commission. The good results have been manifested over the entire country and the demand for the species is increasing year by year. The history of the fish is given in ample detail up to date in previous reports, and it is sufficient here to recall the fact that they are all produced in the city of Washington, for the most part in the ponds at the foot of the Washington Monument, though a portion are raised in the ponds near the Washington Arsenal, the occupation of which has been sanctioned by the War Department. The scale carp are cultivated exclusively at the Arsenal ponds, while the mirror and leather varieties are reared in the Monument ponds.

The area of the Arsenal ponds is about one-fourth of an acre; that of the Monument ponds is given in the accompanying foot-note.*

The increasing demand for carp has made it necessary to extend the facilities for raising them, and an arrangement was entered into for making some new ponds along the line of Virginia avenue, which it is hoped will be ready in time for service in 1884.

The attention of the Commission has been attracted for some time to a new race of carp known as the blue carp, which was supposed to be

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*ELEVATIONS.—Curves of elevation above mean high water are shown for differences of 1 foot; the heights are given in feet.

BENCH-MARK.—The top of the brick wall at the southeast corner of the south wall of the north gate chamber of west pond is 2.875 feet above mean high water of the Potomac River, and was established by the city engineers.

AREAS.

		Acres.
East pond		6.437
West pond (water surface, 6.642 acres; two islands, 0.403 acre)		7.045
North pond	4.346	
South pond	1.500	
Pond No. 1	.078	
Pond No. 2	.086	
Pond No. 5	.157	
Pond No. 6	.178	
Remainder of island, including turtle pond, tanks, ponds Nos. 3 and 4	.576	
Total of north and south ponds combined, including the island between		6.921
Ground between east pond and B street		2.301
Ground between east pond and Executive avenue		.882
Ground between north pond and B street		.229
Ground between north pond and Seventeenth street		.349
Ground between north pond and Executive avenue		.280
Ground between west pond and Executive avenue		2.354
Ground between west pond and Potomac River		.219
Ground between west pond and Seventeenth street		.160
Seventeenth street from B street to Potomac River		2.989
Virginia avenue, as inclosed		2.438
Grand total		30.604

preferable in some respects to the other varieties. Through the courtesy of the *Deutsche Fischerei-Verein*, a number of specimens were received and placed in the ponds. They will be isolated from the other varieties, and their young will be distributed to such persons as wish to have them.

Much trouble is experienced at the United States carp ponds from the attacks of birds, rats, and snakes, the attention of the superintendent and his assistants being constantly occupied in destroying them. During the year more than a thousand water-snakes were destroyed, mostly by shooting them. Many fish-hawks, kingfishers, night-herons, &c., were also killed.

p. **The Goldfish** (*Carassius auratus*).

Central Station.—Goldfish were raised as usual, in large numbers, at the carp ponds under the direction of Mr. Hessel.

During this year there were 5,001 goldfish distributed to 802 applicants, in thirty-three States and Territories.

q. **The Golden Ide or Orf** (*Leuciscus idus*).

This ornamental fish, which occurs in great variety and is very attractive, is cultivated by the Commission for distribution. It attains a length of about 18 inches, is of a beautiful orange red when seen from above, and silvery when observed laterally. It is continually in motion and swims round in schools close to the surface of the water, being in this respect much preferable to the goldfish. It has proved to be a very delicate fish, and though quite a number have been raised and distributed, serious losses are experienced by the cold snaps which kill the eggs.

r. **The Tench** (*Tinca vulgaris*).

A small number of tench are cultivated in the Washington ponds, but there is little demand for them.

s. **The Catfish** (*Amiurus*).

In previous reports reference has been made to the successful introduction of the catfish (*Amiurus nebulosus*) into the waters of California, their multiplication, and the very high esteem in which the fish has been held as an article of food. Specimens have been taken from that State to Nevada by Mr. Parker, fish commissioner of the latter State, where it bids fair to multiply. There are quite a number of species from which a selection may be made, and there is every reason to believe that the fish will in time be in great demand among fish-culturists.

Mr. J. F. Jones, of Hogansville, Ga., has been cultivating one of the Southern species and considers it a very important food-fish, growing very rapidly, living on vegetable substances, and spawning when one year old. A fuller statement of Mr. Jones's experience with this fish will be found on page 321 of vol. iv of the Fish Commission Bulletin.

t. The Clams.

The occurrence on the Pacific coast of the United States of several species of edible clams of very great value has induced the Commission to inquire into the propriety and importance of transplanting them to the waters of the Atlantic, and Mr. R. E. C. Stearns, an eminent conchologist, was requested to visit the localities and make a report upon the subject. As the result of his inquiry he finds that several species are worthy of consideration, especially one of them which normally weighs 4 pounds and occasionally as much as 18. As soon as practicable, the necessary effort will be made for their transplantation. Little if anything, however, can be done until there is railway service to the localities in Washington Territory where the clams can be most readily obtained. A report made by Mr. Stearns on the subject of these clams, with illustrations of the several species, will be found in the Fish Commission Bulletin for 1883.

u. The American Lobster (*Homarus americanus*).

The highly-prized American lobster, which occurs from Labrabor to Delaware Bay, although most abundant in New England, and formerly so plentiful, is now becoming scarce, and much apprehension is felt as to the danger of extinction within a comparatively short period. The diminution in question is not only in number but in size, it being, of course, quite natural that the larger ones should be more closely pursued. A principal cause of this decrease has been the enormous consumption by canning factories, where many millions of pounds are annually put up for exportation to all parts of the world. It is perhaps quite safe to say that within twenty years the decrease all along the coast has amounted from 50 to 75 per cent.

The question of the artificial production of the lobster is one that is beset by many difficulties, especially in view of the fact that the eggs are fertilized within the body of the female, and subsequently attached by a small, short pedicel to the hairs of her legs, where they are kept in constant motion. Artificial impregnation is therefore out of the question, and in what way the eggs can be best developed, whether in connection with the parent or removed and reared in hatching jars, is yet to be settled. Experiments are, however, in progress in this connection, and the results will be published hereafter.

The bulletins of the Fish Commission contain numerous articles on this subject, and in the forthcoming quarto series an elaborate paper by Mr. Rathbun will be found upon the past and present distribution, statistics, &c., of this animal. Something may be done in the way of multiplication of the species by transplantation, and an experiment has lately been tried by the Commissioner in this direction. On August 24 of the present year one hundred live lobsters, partly with eggs, were obtained through the assistance of Mr. E. G. Blackford, of New York, and transported on the Fish Hawk from Fort Pond Bay, Long

Island, to the ripraps in Chesapeake Bay, with the loss of only two or three individuals. It is hoped that future reports may contain a further history of this experiment.

v. The Oyster (*Ostrea virginica*).

Experiments with the eggs and embryos of the common oyster (*Ostrea virginica*) were carried on for the season of 1882 at the experimental station on Saint Jerome Creek, Maryland, by Col. M. McDonald and J. A. Ryder, under the auspices of the U. S. Fish Commission. Other experiments were also conducted at Beaufort, N. C., by Francis Winslow, U. S. N., and Prof. W. K. Brooks, while Mr. Henry J. Rice made investigations in Mr. E. G. Blackford's laboratory, Fulton Market, New York City. Mr. Rice has since then published his results in Forest and Stream and in the thirteenth biennial report of the commissioners of fisheries of the State of New York. His laboratory experiments made upon a limited scale involved the use of two vessels; one as a supply reservoir for the water used in the incubation of the eggs, and another vessel used as a receptacle in which the young oysters were successfully confined. Bands of flannel were used as capillary conductors of the water from the supply reservoir to the hatching-box, and a similar band was used to carry the water from the latter into an outside reservoir. By means of such an apparatus the experimenter was enabled to keep the young oysters, placed in the vessel, alive for fourteen days. Certain improvements in this apparatus made afterwards have rendered it more perfectly adapted to the purpose for which it is designed, that is, the outlet pipe has been so arranged as to prevent the escape of the whole of the water from the hatching-box, and in such a way as to make the method available in the construction of large ponds for the artificial rearing of the oyster.

Mr. Ryder left Washington with the U. S. Fish Commission steamer Fish Hawk in June, 1882, but did not begin any actual experiment until July 3 following. In the course of his investigations in 1882, in cooperation with Colonel McDonald, it was found to be possible to carry young oysters, which had been reared from artificially fertilized eggs to the condition of fixation, twenty-four hours after fertilization, as he has already reported in a paper entitled "An account of experiments in oyster culture and observations relating thereto (second series)," and published in the report of the U. S. Commission of Fish and Fisheries for 1882. These experiments led to the attempts made in 1883, which have resulted in the demonstration of the fact that oyster spat can be reared from artificially impregnated eggs, as was shown experimentally at Stockton, Md., during last season on the premises of Messrs. Shepard and Pierce, these gentlemen generously bearing the expense of the construction of the pond in which the experiments were conducted under the supervision of Mr. Ryder.

The results of the Stockton experiments have been fully described in

an article by Mr. Ryder published in the Bulletin of the U. S. Fish Commission, vol. iii, 1883, pp. 281–294, and it has there been shown that in a pond 3½ feet deep and covering an area of about 50 square yards, connected by a trench 10 feet long with Chincoteague Bay, it was possible to secure spat from artificially fertilized eggs, provided that the fertilized brood introduced into the inclosure was confined by means of a porous diaphragm of sand fixed into the trench, through which the tide could ebb and flow, so as at once to confine such brood and also exclude injurious enemies from entering the pond from the open waters.

Forty-six days after the beginning of this experiment oyster spat from one-fourth to three-fourths of an inch in diameter was found affixed to the shell collectors hung upon stakes in this inclosure. These results have led to the establishment of small breeding ponds at the oyster-cultural station of the U. S. Fish Commission at Saint Jerome Creek, Maryland, where further experiments in artificial breeding will be conducted during the season of 1884, the condition there being now such as to give every indication of the fact that we may reasonably expect to meet with the same success as was had at Stockton last year.

The set of spat during the season of 1883, as elsewhere mentioned, was unusually large, the season being apparently an exceptionally favorable one.

The work of the oyster commission of Maryland in revising the statutes regulating the oyster fishery of that State has also been an important step in testing the effects of restrictive legislation, and we may watch with no small degree of interest the results of the action of the Maryland oyster commission, the views of which have been enacted into statutes by the State legislature.

It may and very probably will be found possible to extend the northern system of deep-water oyster culture to the whole of the deep-water Chesapeake area, in the event of which the States of Virginia and Maryland should take joint action in framing a law or laws the object of which should be to protect and encourage those engaged in the industry. Systematic culture in the Chesapeake Bay can be made to produce great results, and place that region pre-eminently above all others combined as respects the annual yield of oysters.

The year 1883 has also been an unusually noteworthy one in respect to the number of persons who have, as specialists or experts, contributed to our knowledge and life history of the oyster. In the front rank among these must be mentioned Prof. Thomas H. Huxley, who gave an address before the Royal Institution of London, May 11, 1883, which was afterwards published in the English Illustrated Magazine, for October and November, 1883, in which he gives a remarkably clear and readable account of the life history of the European oyster (*Ostrea edulis*), and with characteristic clear-sightedness gives expression to his views as to what is to be done about the oyster question.

The Dutch zoological commission has also been active, and prob-

ably the most noteworthy contribution to the literature of the anatomy of *O. edulis* which has appeared in Europe for thirty years past is a paper entitled "De Voortplantingsorganen van de Oester, Bijdrage tot de kennis van hun bouw en functie," by Dr. P. P. C. Hoek, and illustrated by six well-executed lithographic plates. This paper, published in the Journal de la Société Néderlandaise de Zoologie (Liv. I, 1883), gives for the first time a fully illustrated description in Dutch and French of the organs of Bojanus of *O. edulis.*

The same paper also contains the most complete bibliography extant of works relating to the oyster and oyster culture, which may be consulted by those interested, with the assurance that about all that has been written upon the subject up to within the last two or three years has been noticed.

Professor Horst, of the Dutch commission, has also made some important investigations upon the early stages of development of *Ostrea edulis*, in which he has indicated the true nature of the gastrula stage of this mollusk and the mode in which the supraesophagal ganglion is developed.

During the same period the French naturalists have also been very active, notably G. Bouchon-Brandley and Adrien Certes. The former of these was the first to introduce a successful method of rearing the spat of the diœcious *O. angulata* from artificially impregnated eggs at Verdon, in inclosed ponds, in 1882, though constant daily tidal action was not permitted to effect the change of the water in the ponds as in the American experiments with the eggs of *O. virginica* instituted by Mr. Ryder.

American investigators have been no less active than their foreign brethren. Prof. W. K. Brooks and Lieutenant Winslow—the first as the biological editor of the report of the oyster commission of the State of Maryland, and the latter in his elaborate investigations upon the distribution, area, and condition of the oyster beds of the Eastern United States—have contributed much valuable information upon the subject of the oyster industry of America.

Dr. W. M. Hudson and Hon. Robert G. Pike also deserve particular mention here in connection with their effective efforts in improving the condition of the oyster beds under the jurisdiction of the State of Connecticut.

Mr. J. A. Ryder, of the U. S. Fish Commission, has also been active in contributing towards a knowledge of the life-history of the American oyster. His experiments and investigations have covered a large range of work upon the anatomy, histology, and physiology of the animal. Among the most important of his researches are as follows: Those which have determined the true nature of the "greening of oysters," the absorption of phycocyanin from the diatoms swallowed as food, and its retention by the colorless blood corpuscles of the animal; the structure of the gills, circulatory system, and reproductive and excre-

tory organs; the discovery that the reproductive organs might be almost or altogether atrophied at the end of the spawning season; the elucidation of the effects of osmose and its influence in affecting the bulk and appearance of the flesh of the oyster so as to improve or injure its appearance for the markets, when immersed for a short time in less dense or denser water than that from which the animal was first taken; the true nature of the so-called fattening process, the kinds and distribution of the food of the oyster as well as its messmates and parasites.

Besides the minor papers which Mr. Ryder has issued during the past year upon the subject of oysters and oyster culture he has had prepared under his direction "A Sketch of the Life-History of the Oyster" for the annual report of the geological survey of the Territories for 1883, besides a paper entitled "A Contribution to the Life-History of the Oyster" for the forthcoming quarto fishery report of the U. S. Census. In both of these papers the author has very fully illustrated the anatomy and development of the American oyster with carefully drawn figures.

D.—ABSTRACT OF THE ARTICLES IN THE APPENDIX.

26.—CLASSIFICATION OF ARTICLES.

In the general Appendix to this report will be found a series of forty separate papers treating upon matters relating to the work of the Fish Commission. These are classified under six headings, as follows:

A.—GENERAL.

The first paper is by Lieut.-Commander Z. L. Tanner, and gives a full account of the construction and outfit of the steamer Albatross, illustrated by a number of figures and more than fifty plates. It is followed by his report on the work done by the steamer during the year 1883. In this he has included the subordinate reports of Capt. Jacob Almy, Ensign R. H. Miner, Passed Asst. Surg. C. G. Herndon, Lieut. Seaton Schroeder, and various tables of temperatures, specific gravities, speed of trawlings and soundings, stations occupied, &c. A paper by Livingston Stone is entitled "Explorations on the Columbia River, from the head of Clarke's Fork to the Pacific Ocean, made in the summer of 1883, with reference to the selection of a suitable place for establishing a salmon-breeding station." This is followed by a reprint of the Brstish sea-fisheries act of 1883.

B.—THE FISHERIES.

In this section are found ten papers, the first giving a tabulated estimate of the catch of fish of the principal rivers of the United States in 1880. This was prepared by Mr. Smiley from material collected during the work on the Tenth Census, and shows a total of 184,783,050 pounds.

The same author presents the statistics of the United States imports and exports of fishery products for the current year. These are based upon information furnished by the Bureau of Statistics. A paper on the fisheries of Great Britain and the Fisheries Exhibition of 1883, by R. W. Duff, M. P., is presented in abstract as somewhat explanatory of the great International Fisheries Exhibition. Of the two papers relating to the whale fisheries, the first is a statistical review of the past two years, compiled by Mr. Smiley, and the second a translation from the German of a description of Svend Foyn's whaling establishment. A translation from the Swedish of Prof. A. V. Ljungman upon the great herring-fisheries is of interest. It is followed by two papers from the Danish upon the Norwegian fisheries of 1883, and the Iceland cod-fisheries of 1883. A paper upon the fisheries of India by Francis Day, formerly inspector-general of fisheries in India, gives a very comprehensive view of that industry. The last paper is by Rudolph Lundberg, upon the Swedish eel-fisheries and the apparatus used therein.

C.—Economic Research.

Prof. W. O. Atwater has presented herein his second contribution to our knowledge of the chemical composition and nutritive values of American food-fishes and invertebrates, a former paper on the same subject having been furnished by him for the Report of 1880.

D.—Natural History and Biological Research.

Of the six papers in this section the first two relate to the explorations made by the Commission along the Gulf Stream, Professor Verrill presenting the general results of the Albatross explorations in 1883, and Miss Bush giving a list of the deep-water mollusca dredged by the Fish Hawk in 1880, 1881, and 1882. In a paper by A. V. Ljungman, translated from the Swedish, will be found some valuable notes upon the natural history of the herring and the management of the herring fisheries during the past ten years. A paper by R. W. Shufeldt, M. D., upon the osteology of *Amia calva* is illustrated by fourteen plates; and one by Gustav Eisen, entitled "Oligochætological Researches," is illustrated by ten plates. The last paper is by William P. Seal, upon the aqua-vivaria as an aid to biological research, and is illustrated by three plates.

E.—Propagation of Food-Fishes.

The sixteen papers in this section relate mostly to the propagating operations of the Fish Commission, and consist of reports from the persons charged with the work of propagation or distribution. These are upon the fish eggs sent to foreign countries, by Mr. Mather; the operations at Northville and Alpena Stations, by Mr. Clark; the salmon- and trout-breeding work on the McCloud River, by Mr. Stone; the Penobscot and Schoodic salmon work in Maine, by Mr. Atkins; the

miscellaneous work at the Central Station, by Mr. McDonald; the shad-hatching operations at Fort Washington, by Lieutenant Babcock; the shad-hatching at Havre de Grace, by Lieutenant Lowe; the experiments in penning shad, by Mr. Clark; the general work of distribution, by Mr. McDonald; and the hatching of Spanish mackerel, by Lieutenant Wood and by Dr. Kite. There are also included three papers upon carp culture, which have been considered worthy of translation from the German, the first by Prof. B. Benecke, the second by Max von dem Borne, and the third by Adolph Gasch.

F.—MISCELLANEOUS.

In this section will be found a short account of the laying out of oyster ponds at Saint Jerome, by Lieutenant Wood; suggestions to keepers of life-saving stations and others, relative to the best means of collecting and preserving specimens of whales and porpoises, by F. W. True; and a compilation of statements concerning the fisheries of several different countries, as reported by the United States consuls abroad to the United States Department of State.

This series of forty papers contains many that are considered of very high value, and is illustrated by more than one hundred and fifty plates. Ten of the longest papers are provided with special indexes, as it is often desirable to issue these in separate pamphlet form for distribution to specialists not interested in the contents of the entire volume.

E.—SUPPLEMENT TO THE REPORT PROPER.

27.—LIST OF LIGHT-HOUSE KEEPERS RENDERING ASSISTANCE.

The following is a list of the light-houses (with their keepers) at which temperatures and occurrences of ocean fish have been observed during a portion or all of the present year:

List of light-houses on the Atlantic coast at which ocean temperatures have been taken during the year 1883, together with the number of monthly reports made at each one.

Petit Manan light-house, Petit Manan Island.	
George L. Upton, Millbridge, Me	12
Mount Desert light-house, Mount Desert Rock.	
Thomas Milan, Southwest Harbor, Me	12
Matinicus Rock light-house, Penobscot Bay.	
William G. Grant, Matinicus, Me	12
Seguin light-house, Seguin Island, Kennebec River.	
Thomas Day, Hunnewell's Point, Me	12
Boon Island light-house.	
Alfred J. Leavitt, box 808, Portsmouth, N. H	12
Minot's Ledge light-house, Cohasset Rocks, Boston Bay.	
Frank F. Martin, Cohasset, Mass	12
Race Point light-house, Cape Cod Bay.	
James Cashman, Provincetown, Mass	12
Pollock Rip light-station, entrance to Vineyard Sound.	
Joseph Allen, jr., South Yarmouth, Mass	12

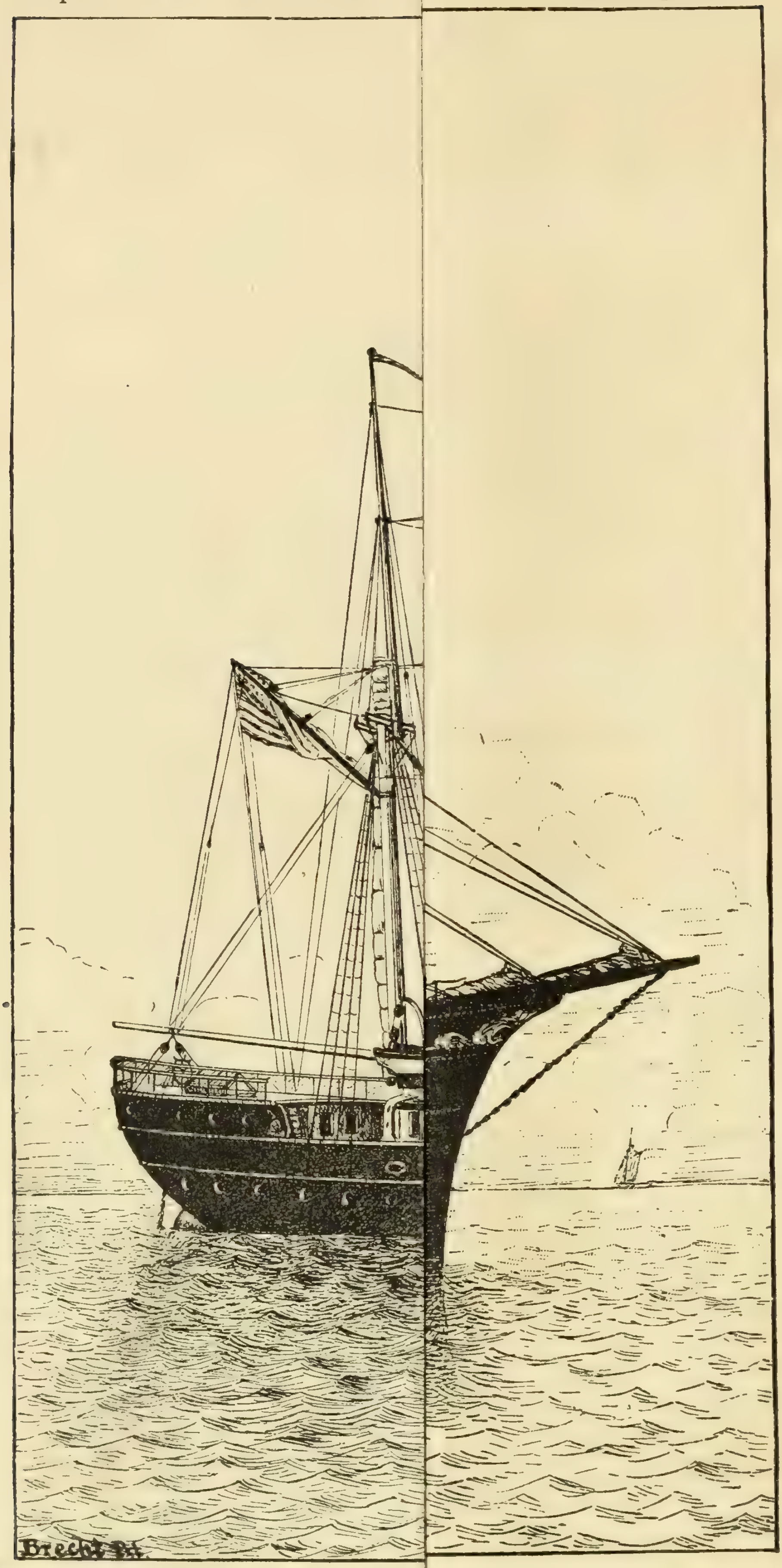
Nantucket New South Shoal light-station, Davis New South Shoal.
Andrew J. Sandsbury, Nantucket, Mass 12
Cross Rip light-station, Vineyard Sound.
Luther Eldredge, Chatham, Mass 12
Buoy Depot, Government wharf, office inspector second division.
Benjamin J. Edwards, Wood's Holl, Mass 12
Vineyard Sound light-station, Sow and Pigs Rocks.
William H. Doane, 13 Kempton street, New Bedford, Mass 12
Brenton's Reef light-station, off Brenton's Reef and Newport Harbor.
Charles D. Marsh, Newport, R. I 12
Block Island light-house, southeast end of Block Island.
H. W. Clark, Block Island, R. I 12
Bartlett's Reef light-station, Long Island Sound.
Daniel G. Tinker, New London, Conn 12
Stratford Shoals light-house, Middle Ground, Long Island Sound.
James G. Scott, Port Jefferson, N. Y 12
Fire Island light-house, south side of Long Island.
Seth R. Hubbard, Bay Shore, N. Y 12
Sandy Hook light-house, entrance to New York Bay.
James Cosgrove, 128 Rutledge street, Brooklyn, N. Y. (succeeded by A. H. Pritchard, 120 Spencer street, Brooklyn, E. D., N. Y., in April) 12
Absecom light-house, Absecom Inlet.
A. G. Wolfe, Atlantic City, N. J 12
Five-Fathom Bank light-station, off Delaware Bay.
William W. Smith, Cape May City, N. J 12
Fourteen-Foot Bank light-station, Delaware Bay.
Ed. A. Howell, Delaware City, Del. (succeeded by John Lund, Wilmington, Del., in October) 12
Winter-Quarter Shoal light-station, Chincoteague Island.
C. Lindemann, 857 Broadway, Brooklyn, E. D., N. Y 12
York Spit light-house.
James K. Hudgins, Port Haywood, Va 9
Wolf Trap Bar, Chesapeake Bay, Virginia.
John L. Burroughs, New Point, Matthews County, Va 12
Stingray Point light-house.
C. S. Lankford, Sandy Bottom, Va. (succeeded by Charles F. Sadler, Hudgins, Va., in April) 12
Windmill Point, mouth of Rappahannock River.
James G. Williams, Hookumfair, Va 12
Body's Island light-house, north of Cape Hatteras.
Peter G. Gallop, Manteo, Dare County, N. C 12
Cape Lookout light-house, Cape Lookout.
Deward Rumley, Beaufort, N. C 12
Frying-Pan Shoal light-station, Cape Fear.
John D. Davis, Smithville, N. C 12
Rattlesnake Shoal light-station, off Charleston.
John McCormick, Charleston, S. C 12
Martin's Industry light-station, Port Royal Entrance.
John Masson, Port Royal, S. C 12
Fowey Rocks light-house, Fowey Rocks.
John J. Larner, Miami, Fla 12
Carysfort Reef light-house, Florida Reefs.
F. A. Brost, Key West, Fla 11
Dry Tortugas light-house, Loggerhead Key.
Robert H. Thompson, Key West, Fla 12

APPENDIX A.

GENERAL.

U. S. Fish Commission steamer Albatross.

Frontispiece.



I.—REPORT ON THE CONSTRUCTION AND OUTFIT OF THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS.

BY LIEUTENANT-COMMANDER Z. L. TANNER, U. S. N.

CONTENTS.

A.—Preface by the Commissioner.
B.—Construction of the Albatross.
C.—Steam machinery and mechanical appliances. By Engineer Baird.
D.—Apparatus for deep-sea research.
E.—General description of methods of sounding, &c.
F.—Other apparatus.
G.—Co-operation of the Navy Department.

A.—PREFACE BY THE COMMISSIONER.

The alleged decrease of the food-fishes along the sea-coasts and in the lakes of the United States induced the passage by Congress, in 1871, of an act authorizing the appointment by the President, with confirmation by the Senate, of a Commissioner of Fish and Fisheries to investigate the subject and report the facts as ascertained, with any recommendations that might seem desirable; and Prof. Spencer F. Baird, the then Assistant Secretary of the Smithsonian Institution, received the appointment.

The investigations in question were at first restricted to the examination of the inshore waters; but the many questions arising in regard to the movements of the mackerel, the bluefish, the menhaden, and other pelagic species, caused the Commissioner to make application to Congress for means to build a sea-going steamer, by the aid of which the movements of the sea fish could be more readily followed, and their lines of migration and winter habitat determined. An appropriation of $103,000 was accordingly made in 1881 for building such a vessel, which was, however, found insufficient to construct a steamer upon the approved plans of Mr. Charles W. Copeland, of New York. An additional sum having been allowed by Congress, making an aggregate of $145,000, proposals were invited, and Messrs. Pusey & Jones, of Wilmington, Del., being the lowest bidders, and their offer coming within the amount of the appropriation, work was commenced by that firm in March, 1882, and the trial trip was made December 30, 1882.

Some repairs and alterations made it necessary to send the steamer back to the ship-yard of the builders; and in April, 1883, the vessel made her first cruise on the business of the Commission.

Lieut. (now Lieutenant-Commander) Z. L. Tanner was ordered by the Navy Department to superintend the construction of the vessel. He made many important suggestions, and his practical experience was of the utmost benefit in the final determination of the plan of construction. The equipment of the vessel was entirely under his direction, and to his ingenuity is due a large number of the novel and important devices and improvements adopted.

SPENCER F. BAIRD,
Commissioner.

B.—CONSTRUCTION OF THE ALBATROSS.

The United States Fish Commission steamer Albatross is an iron twin-screw vessel, built by the Pusey and Jones Company, of Wilmington, Del. She was launched August 19, 1882 (see frontispiece).

Her general dimensions are as follows:

Length over all, 234 feet.
Length at 12-foot water-line, 200 feet.
Breadth of beam, moulded, 27 feet 6 inches.
Depth from top of floor to top of deck beams, 16 feet 9 inches.
Sheer forward, 5 feet 2 inches.
Sheer aft, 3 feet.
Height of deck-house amidships, 7 feet 3 inches.
Displacement on 12-foot water-line, 1,074 tons.
Registered tonnage (net), 384 tons.

ANCHORS AND CHAINS.

One 1,900 pounds, 120 fathoms, $1\frac{5}{8}$-inch chain.
One 1,288 pounds, 120 fathoms, $1\frac{3}{16}$-inch chain.
One 1,030 pounds.
One 600 pounds, 250 fathoms. Bullivant's.
Elastic steel wire cable, $3\frac{1}{2}$ inches diameter.

She is rigged as a brigantine, carrying sail to a foretop-gallant sail. The spars are of white pine and spruce, and the following are their dimensions, viz:

SPARS.

Name.	Feet.	Diameter in inches.
Mainmast above main deck	56	20
Maintop-mast above cap	32	$9\frac{1}{2}$
Foremast above deck	52	21
Foretop-mast above cap	30	$10\frac{1}{2}$
Fore yard, length	50	11
Foretop-sail yard, length	40	9
Foretop-gallant yard, length	$27\frac{1}{2}$	$5\frac{1}{3}$
Fore gaff	27	$7\frac{1}{2}$
Main boom	56	$12\frac{1}{2}$
Main gaff	36	$9\frac{1}{2}$
Dredging boom	36	10

Bowsprit, 13 inches square, 10 feet outboard to shoulder. Round-top on foremast. Cross-trees on mainmast.

SAILS.

Name.	Canvas.	Square feet.
Mainsail	No. 2	1,488
Gaff-topsail	No. 7	578
Foresail (27-foot drop)	No. 2	1,156
Fore trysail	No. 2	872
Foretop-sail (24¾-foot hoist)	No. 4	934
Foretop-gallant sail (14¼-foot hoist)	No. 6	389
Fore staysail	No. 2	660
Jib	No. 5	918
Flying jib	No. 6	526
Total sail area		7,521

Index to the detailed plans of the steamer Albatross.

No.	Articles.
	POOP-HOUSE AND FORECASTLE DECKS (PLATE II).
1	Forecastle.
2	Wooden bitts.
3	Fish-davit.
4	Capstan (connected with steam windlass).
5	3-inch rifled howitzer.
6	Sigsbee deep-sea sounding machine.
7	Top of pilot-house.
8	Top of deck-house.
9	Bridge.
10	Skylight over chart-room and laboratory.
11	Whale-boat.
12	Seine-boat.
13	Standard compass.
14	Smoke-stack.
15	Ventilator to fire-room.
16	Skylight over drum-room and galley.
17	Steam-gig (Herreshoff).
18	Steam-cutter (Herreshoff).
19	Engine-room skylight.
20	Dinghy.
21	After compass.
22	Mainmast.
23	Main boom.
24	Bridge from top of poop to top of deck-house.
25	Poop-deck.
26	Cabin skylight.
27	Iron bitts.
28	Screw steering-gear.
	MAIN DECK.
29	Paint locker.
30	Chain cables.
31	Stopper for chain cables.
32	Compressor for steel-wire hawser.
33	Steam windlass.
34	Forecastle pump.
35	Lamp room.
36	Bath-room for steerage officers.
37	Water-closets.
38	Iron bitts.
39	Fore hatch.
40	Hoisting engine.
41	Dredging boom.
42	Dredge-rope rove for use.
43	Tanner sounding-machine.
44	Foremast.
45	Ship's bell.
46	Pilot-house.
47	Steam or hand steering gear.
48	Binnacle.
49	Signal-locker.
50	Deck-lights.
51	Chart-room.
52	Steam-heater.
53	Chart-table.
	MAIN DECK—continued.
54	Washstand.
55	Chronometer chest and lounge.
56	Berth.
57	Bunker-plate and coal-chute.
58	Upper laboratory.
59	Hatch to lower laboratory.
60	Work-table for naturalists.
61	Dispensary case.
62	Bookcase.
63	Sink.
64	Steam-heater.
65	Naturalists' state-rooms.
66	Berth.
67	Washstand.
68	Bureau.
69	Steam-drum.
70	Ash-chute.
71	Ventilators for fire-room.
72	Iron grating.
73	Galley.
74	Dresser.
75	Baird's distiller.
76	Upper engine-room.
77	Iron bitts.
78	Wardroom companion-way.
79	Wardroom skylight.
80	Commanding officer's cabin.
81	Cabin pantry.
82	Commanding officer's office.
83	State-room.
84	Berth.
85	Bureau.
86	Washstand.
87	Lounge.
88	Sideboard.
89	Table.
90	Steam-heater.
91	Bath-room.
92	Rudder-head.
93	Water-tank.
94	Silver-closet.
95	Linen-closet.
	BERTH DECK.
96	Yeoman's store-room.
97	Fore passage.
98	Dredging store-room.
99	Brig.
100	Chain-pipes leading to chain-lockers.
101	Collision bulkhead.
102	Hatch to ice-box.
103	Air-port.
104	Bag-rack.
105	Hatch to forehold.
106	Steam-heater.
107	Reeling-engine.
108	Governor pulley.

Index to the detailed plans of the steamer Albatross—Continued.

No.	Articles.	No.	Articles.
	BERTH DECK—continued.		BERTH DECK—continued.
109	Steerage.	145	Ventilating-pipe.
110	Steerage-rooms.	146	Quadrant of rudder.
111	Berth.		
112	Bureau.		HOLDS.
113	Washstand.	147	Magazine.
114	Table.	148	Magazine-passage.
115	Open pantry.	149	Fore-peak.
116	Water tight iron bulkhead.	150	Ventilating pipe with branches.
117	Lower laboratory.	151	Keelson.
118	Lockers for specimen bottles.	152	Keel.
119	Steam-heater.	153	Chain-lockers.
120	Sink.	154	Collision bulkhead.
121	Table.	155	Ice-box.
122	Photographer's dark-room.	156	Cold-room.
123	Coal-chutes.	157	Upper hold.
124	Air-ports.	158	Lower hold.
125	Coal-bunkers.	159	Steel wire hawser-reel.
126	Boilers.	160	Store-rooms.
127	Exhaust-fan for ventilating the vessel.	161	Fresh-water tanks.
128	Iron grating.	162	Water-tight iron bulkheads.
129	Main engines.	163	Laboratory store-room.
130	Dynamo-machine (Edison).	164	Ballast-room and sinkers.
131	Wardroom companion-ladder.	165	Water-tight iron bulkhead.
132	Wardroom pantry.	167	Boiler leg.
133	State-room.	168	Fire-room.
134	Bureau.	169	Lower engine-room.
135	Washstand.	170	Water-tight iron bulkhead.
136	Berth.	171	Wardroom store-room and shaft-alleys.
137	Wardroom.	172	Water-tight iron bulkhead.
138	Table.	173	Paymaster's store-room.
139	Steam-heater.	174	Equipment store-room.
140	Lounge.	175	Propeller-shaft.
141	Iron water-tight deck.	176	A-frames for propeller-shaft.
142	Bath-room.	177	Propeller.
143	Cabin store-room.	178	Rudder.
144	Quadrant-room.	179	Rudder-chains.

HULL.

The Albatross has a "bar" keel of the best hammered iron, 8 by $2\frac{1}{4}$ inches, scarfs 25 inches in length. There is one bilge keel on each side $10\frac{1}{4}$ feet from the center line, parallel thereto, of two angle-irons 4 by 6 by $\frac{5}{8}$ inches, with a $\frac{7}{8}$ inch iron plate 16 inches deep riveted between, 80 feet in length, tapering in depth to nothing at each end.

The stern-post is of the best hammered iron, $7\frac{1}{2}$ by $2\frac{1}{2}$ inches; and the stern is of the same material, $7\frac{1}{2}$ by $2\frac{1}{4}$ inches.

The frames are of angle-iron; those under the engines and boilers 4 by 3 by $\frac{7}{16}$ inches; forward and aft of these they are $3\frac{1}{2}$ by 3 by $\frac{7}{16}$ inches. Frames and floor spaces, 21-inch centers.

The floors are in one piece 18 inches deep and $\frac{8}{16}$ inch thick for three-fifths the vessel's length amidships, $\frac{7}{16}$ inch thick forward and aft. They are on every frame extending 20 inches above the top of the floor amidships, molding to the size of the frames.

One limber-hole is cut on each side of the center keelson. Enlarged floors with necessary angle-irons and strengthening plates are provided for the foundations of the engines and boilers.

REVERSE BARS.

The reverse bars are of angle-iron, 3 by 3 by $\frac{6}{16}$ inches, one on every frame extending to the stringer plate and 12 inches above the upper turn of the bilge alternately. There are double reverse bars on all frames under the engines and boilers, and also on the line of all keelsons, hold stringers, and bulkheads. Joints are covered with angle-iron butt-straps, not less than 18 inches in length, with three rivets in each end.

KEELSONS.

On top of the reverse bars there is a center keelson, 12 by $4\frac{1}{2}$ inches, beam iron, $\frac{5}{8}$ inch thick for three-fifths the length amidships, and $\frac{4}{8}$ inch thick forward and aft. On each side, 8 feet 8 inches from the center line, there is a keelson of two channel bars, $7\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{5}{16}$ inches, riveted back to back; and at the bilge on each side a keelson of two angle-irons, 6 by $3\frac{1}{2}$ by $\frac{7}{16}$ inches, riveted back to back. The bilge keelsons conform to the shape of the floors, and the side keelsons run parallel to the center line. There is also a cross keelson for the shaft stuffing-boxes.

At a distance of 4 feet 7 inches from the center line on each side there runs a keelson of beam iron, 8 by $4\frac{1}{2}$ by $\frac{5}{8}$ inches, riveted to the reverse bars.

INTERCOSTAL KEELSONS.

Of these there is one of $\frac{6}{16}$ inch plate run on the center line, and one of $\frac{5}{16}$ inch plate under each side keelson, extending from keel to top of floors, well fitted between floors, and connected with them by an angle-iron $2\frac{1}{2}$ by $2\frac{1}{2}$ by $6\frac{6}{16}$ inches.

DECK BEAMS.

Additional intercostal keelsons are placed under the engines.

For the main deck they are of T bulb-iron, on alternate frames, 7 by $3\frac{3}{4}$ by $\frac{7}{16}$ inches for three-fifths the vessel's length amidships; forward and aft they are 6 by $3\frac{3}{4}$ by $\frac{3}{8}$ inches, except at the capstan and riding-bitts forward, and at hatches, where they are 8 by $\frac{7}{16}$ inches.

STRINGERS.

The main-deck stringers on each side are 38 inches wide by $\frac{4}{8}$ inch in thickness at midlength, reduced to 26 inches width at the end. Stringers are connected with sheer-strake by angle-irons, $4\frac{1}{2}$ by $3\frac{1}{2}$ by $\frac{7}{16}$ inches, securely riveted to both the deck beams and sheer-strake. At the foremast and mainmast there is riveted to the deck beams a stringer plate 42 inches wide and $\frac{3}{8}$ inch thick, long enough to cover two beams forward and aft of the mast, securely riveted to the deck beams; through this plate a hole for the mast is cut. Similar tie-plates, covering three or four beams, are riveted in wake of bitts, windlass, capstan, hoisting engine, and reeling engine.

TIES OF MAIN DECK

are run fore and aft from end to end each side of center line, at such distance from it as to clear all hatches. They are of plate iron, 15 by $\frac{1}{2}$ inches, securely riveted to deck beams and to stringer plates or breast hooks at the end; butts closely fitted and butt-straps double riveted. The width of these plates is gradually reduced to 9 inches forward and aft.

HOLD STRINGERS

are 24 inches wide by $\frac{1}{2}$ inch thick at midlength, gradually reduced to 18 inches in width at the ends, and are run fore and aft on frames at a height of 10 feet above top of floors, connected to deck beams and reverse bars by angle-irons. Alongside of the engines and boilers, where there are no hold-beams, these angle-irons are doubled back to back and riveted through.

BEAMS OF BERTH DECK.

Forward and aft of engines and boilers, and between them, there are hold-beams of channel-iron, 6 by $2\frac{1}{8}$ by $\frac{3}{8}$ inches, spaced to every alternate frame, connected and riveted to hold stringers and frames, and kneed to frames the same as the main-deck beams.

IRON DECK-HOUSE.

The sides of the midship deck-house from the after end of the house to the bulkhead forward of the funnel, including these two bulkheads, are of plate iron, No. 5 wire gauge; stanchions, of 3 by 3 inches, angle-iron, spaced 24 inches from center to center. The beams are of angle-iron, 3 by 3 by $\frac{5}{16}$ inches, riveted to stanchion and to stringer and hatch-plate below.

PLATING.

The plating is run in fair lines, in and out strakes; all horizontal seams are lapped and all vertical seams, including bulwarks, are butted; spaces between outer strakes and frames are filled with liners of proper width and thickness.

The garboard-strake is $\frac{10}{16}$ inch thick for three-fifths its length amidships, gradually reduced to $\frac{8}{16}$ inch at the ends, and is 32 inches wide.

Sheer-strakes are fayed next to frames, $\frac{10}{16}$ inch thick for one-half the length amidships, gradually reduced to $\frac{8}{16}$ inch at the ends, and 38 inches wide. The upper edge extends $3\frac{1}{2}$ inches above top of plank-sheer to connect bulwark plates.

Bulwark plates from sheer-strake to rail are $\frac{5}{16}$ inch thick, well riveted to sheer-strake and frames. The whole length of the upper edge of the bulwark plates, on the outside, is run an angle-iron, $3\frac{1}{2}$ by $3\frac{1}{2}$ by $\frac{3}{8}$ inches, well riveted to bulwark plates, with proper lap-strips at the butts. To this angle-iron the rail is fastened.

The side-strake next below the sheer-strake is $\frac{4}{8}$ inch thick at mid-

ship length, gradually reduced to $\frac{7}{16}$ inch forward and aft. The remaining side plating is $\frac{6}{16}$ inch thick, except the strakes around the shaft-pipe, which are of $\frac{7}{16}$ inch and are doubled, and the bilge-strake, which is $\frac{9}{16}$ inch thick for two-thirds the length amidships, gradually reduced forward and aft to $\frac{7}{16}$ inch.

The bottom between bilge and garboard strakes is $\frac{4}{8}$ inch thick for three-fifths the length amidships, then gradually reduced to $\frac{7}{16}$ inch forward and aft.

All butts of plating, keelsons, and stringers are double chain riveted, and the longitudinal seams lapped and single riveted.

All plates are long enough to cover at least six frame spaces, except short plates at the ends; and there are at least two strakes between butts falling between same frames. All edges and butts are planed.

Butts of garboard-strakes are at least two frame spaces apart, as also are those of sheer-strakes and deck stringers. All butts of plating are properly shifted.

RAIL.

The rail is of white oak, $10\frac{1}{2}$ by $3\frac{1}{2}$ inches, let down to a fair bearing on the bulwark angle-iron, hook-scarfed and edge-bolted through scarfs.

MAIN DECK (PLATE II).

CABIN (PLATE III).

Of the structures which rise above the main rail the poop cabin extends 30 feet forward from the stern-post, is the whole width of the vessel, and 7 feet 3 inches high from deck to deck. It contains two state-rooms, an office, pantry, and bath-room, besides lockers, &c., and is supplied with light and air from eleven air-ports (five on each side and one in the stern), two windows, and three doors opening forward, and one skylight 6 feet by 5 feet overhead.

DECK-HOUSE.

Forward of the cabin there is a clear space of 16 feet containing the wardroom skylight, and from which the gangway ladders lead over the side. Next comes the deck-house, 83 feet in length, 13 feet 6 inches in width, and 7 feet 3 inches in height. It is built of iron from the funnel aft, sheathed inside and out with wood, and fitted with iron storm-doors. From the funnel forward it is of wood, all fastenings, nails, screws, &c., being of galvanized iron. Beginning aft it is divided into the following apartments:

1. ENTRANCE TO WARDROOM.

Six feet in length and the whole width of the house. One window on each side furnishes light and air, and two doors opening aft give access to the stairway leading to the wardroom below.

2. UPPER ENGINE-ROOM.

This is 10 feet 6 inches in length and the full width of the house. It has one door and one window on each side, a skylight 5 by 5 feet overhead, and a stairway leading to the engine-room below. The inside wooden doors of this room, as well as those of the kitchen and drum-room next forward, are fitted in halves, upper and lower, so that in bad weather the lower halves may be closed to keep out the water, while the upper are open for ventilation.

3. KITCHEN.

In length 8 feet, the whole width of the house, with one door and one window on each side, and a skylight 4 by 5 feet overhead. It is furnished with a table, fuel-boxes, lockers, dish-racks, and a lead-lined sink fitted with a pump, drawing water from the tanks in the hold.

4. DRUM-ROOM.

This is also the entrance to the fire-room, is 13 feet 6 inches in length, and the width of the house. It is fitted with doors and windows like those of the engine-room, has a skylight 4½ by 5 feet overhead, and communicates by a stair-way with the fire-room below. As its name implies, this room contains the steam-drum, which is so designed that the funnel passes up through it, thus utilizing the heat of the escaping products of combustion to superheat the steam.

5. STATE-ROOMS.

Forward of the drum-room the wooden part of the deck-house commences with four state-rooms, two on each side, for the members of the scientific corps. Each room is 6 feet 6 inches in length, half the width of the house, and has a door and window with blind shutters, a berth 30 inches in width, a writing-desk, washstand, drawers, lockers, &c. Additional ventilation is secured by lattice-work openings, outboard, and also between the rooms.

6. UPPER LABORATORY (PLATE IV).

This is 14 feet in length and the whole width of the house. It is supplied with light and air by two windows and a door on each side and a skylight 6 by 3 feet overhead. In the center is a very conveniently arranged work-table, square in shape, around which four persons can seat themselves, each having at his right hand a tier of drawers which form the legs of the table. There are also two hinged side-tables, a sink with alcohol and water tanks attached, wall cases for books and apparatus, and in one corner a medical dispensary.

7. CHART-ROOM (PLATE V).

Immediately forward of the laboratory is the chart-room, 8 feet 6 inches in length, the full width of the house. It has one door and

window on each side and a skylight 3 by 3 feet above, drawers for charts, &c., a berth, washstand, lockers, book-shelves, and a transom sofa, which is also used as a chronometer chest. A door in the forward bulkhead gives access to the pilot-house.

8. PILOT-HOUSE (PLATE VI).

This is the next and last division of the deck-house. It is 8 feet in length, the full width of the house, and has one door on each side. The front is elliptical, with glass windows, balanced by weights, and protected in bad weather by strong wooden shutters hung in the same manner as the windows and fitted with 8-inch bull's-eyes in the center.

The pilot-house is raised about 3 feet above the main-deck and projects the same distance above the top of the house, with which it communicates by two windows. Suitable bell-pulls and speaking-tubes furnish the necessary means of communication with the engine-room, and instead of the ordinary ship's wheel a Higginson's steam quartermaster is used.

TOP-GALLANT FORECASTLE.

The top-gallant forecastle is 44 feet in length and 6 feet 3 inches in height between decks. On it are stowed the anchors, which are handled by a single fish-davit amidships and a capstan which can be worked by hand or by the steam-windlass (Plate XIV) directly underneath. On the port side aft is the Sigsbee deep-sea sounding machine, and just abaft the capstan is a 3-inch breech-loading rifle mounted on a boat carriage.

Underneath the forecastle are water-closets for officers and men, bath-room for men, lamp-room, paint-locker, steam-windlass, and carpenter's bench. Two scuttles give access, one to the store-rooms, magazine, &c., forward of the collision bulkhead, and the other to the berth deck.

BERTH DECK (PLATE VII).

This includes the space 40 feet aft from the collision bulkhead, and is 7 feet 10 inches between decks. It is supplied with light and air by the fore hatch, fore scuttle, and by eight 8-inch air-ports, four on each side. Racks for stowing bags and hammocks are fitted along the sides; the space abaft the fore hatch is occupied by the reeling-engine, and near the forward bulkhead are two scuttles opening into the ice-boxes.

ICE-BOXES.

These occupy the space 7 feet aft from the collision bulkhead the whole width of the ship. A strong fore and aft bulkhead amidships divides this space into two compartments; the sides and ends are fitted double with an intervening air-space of four inches which is filled with proper non-conducting material. The inside is lined throughout with

galvanized iron, and, at the after outboard corners, lead pipes with suitable traps drain the water into the hold. The capacity of the ice-boxes is about 3 tons each, 6 tons in all.

COLD-ROOM.

The after part of the space in the ice-boxes for two feet is partitioned off by an athwartship bulkhead to form a cold-room or refrigerator, to which access is gained by doors opening into the fore hold. Six-inch openings at the top and bottom of the cold-room communicate with the ice-lockers, and a circulation of air is induced as the warmer air of the former rising passes above into the latter, becomes cooled by the ice, falls and re-enters the cold-room by the lower opening, to become warmer again and rise as before.

Rack-shelves to hold whatever is desired are fitted against the bulkhead.

STORE-ROOMS, MAGAZINE, BRIG, ETC.

Forward of the berth deck, and separated from it by the collision bulkhead, is a fore and aft passage-way to which access is gained by a scuttle and stairs underneath the top-gallant forecastle.

This passage opens forward into the yeoman's store-room, to the right into the brig, lighted and ventilated by an 8-inch air-port, and to the left into the dredging store-room, similarly furnished with light and air.

Through this passage, also, the chain pipes pass down and aft, taking the chain from the windlass to the lockers below, and from the forward end of the passage a scuttle and stairs lead down to the magazine passage and magazine, and to the fore peak below them.

FORE HOLD.

Below the berth deck the space from the cold-room aft is taken up by the fore hold, steerage store-room, engineer's store-room, bread-room, sail-room, and water-tanks. Access is gained by a hatch directly under the fore hatch.

STEERAGE (PLATE VIII).

Opening from the after end of the berth deck is the steerage, containing four double-berth state-rooms, 6 feet 6 inches in length, two on each side, and a mess-room 13 feet in length between. It is lighted and ventilated by an 8-inch air-port in each room, a 12-inch ventilator cut through the deck just abaft the foremast, and the door opening from the berth deck. Each room has an upper and lower berth 30 inches wide, a bureau, washstand, toilet racks, drawers, shelves, &c. On the forward bulkhead of the mess-room is an open pantry.

LOWER LABORATORY (PLATES IX AND X).

Abaft the steerage, but separated from it by a water-tight iron bulkhead, is the lower laboratory immediately below the upper laboratory,

through which only can it be entered. This room extends quite across the ship, is 20 feet fore and aft, 7 feet 10 inches between decks, and is furnished with light and air by six 8-inch air-ports, two 12-inch deck-lights, and the hatch leading above.

Ample and convenient storage cases and lockers are provided for alcohol tanks, jars, and specimens in bottles of all sizes; long work-tables are fitted along each side; in one after corner is a lead-lined sink with running water; in the other a photographic dark-room; and along the bulkhead between the two is the chemical laboratory. Between the beams overhead are slings and hooks for stowing dip-nets, scoop-nets, harpoons, spears, lances, and other fishing appliances.

A hatch and stairs lead to the store-room below, a closed iron box capable of being isolated from the rest of the ship and filled with steam at short notice in case of fire. Here are stowed alcohol in tanks, nets, sieves, &c., for which suitables lockers have been provided.

Below this store-room is a small space next the skin of the ship where the sinkers used in sounding are stored.

WARDROOM (PLATE XI).

The whole space from the laboratories aft to the wardroom is occupied by the engines and boilers, bunkers, &c., and will be described in connection with them.

The wardroom is 38 feet in length, the full width of the ship, and 7 feet 10 inches in height from deck to deck. It is lighted and ventilated by seven 8-inch air-ports on each side, a skylight 6 by 5 feet overhead, and the stairway leading to the deck above.

The space on either side of the stairway is occupied by the pantry on one side, and the chief engineer's room on the other; the latter communicating by a door with the engine-room immediately forward. Abaft these rooms a space 13 feet in length and the whole width of the ship is reserved for an athwartship extension-table, seating, at most, twelve persons. Along the sides of this space are fitted cushioned sofa transoms.

There are four rooms on each side, the starboard after one being furnised as a bath-room, the others containing a berth, bureau, washstand, drawers, lockers, &c. Two scuttles in the wardroom floor give access to store-rooms below; the paymaster's store-room forward, an iron water-tight compartment, and the equipment and navigator's store-room.

A scuttle in the pantry floor leads to the wardroom store-room, also a water-tight compartment. A door opens into a locker under the stairs.

The vessel is lighted throughout by electricity; and artificial ventilation is produced by means of an exhaust fan and conduit pipes to every compartment below the main deck.

BOATS.

The Albatross has five boats, as follows:

HERRESHOFF STEAM CUTTER.

The Herreshoff steam cutter is 26 feet 6 inches in length, 7 feet beam, and 3 feet 10 inches in depth, with double coil boiler and compound engine, cylinders 6 inches and $3\frac{1}{2}$ inches in diameter and 7-inch stroke, developing 16 horse-power with 100 pounds of steam. It has a keel condenser, and carries an average of 26 inches vacuum. The bunkers hold 1,100 pounds of coal, and the fresh-water tank, which is placed directly underneath the boiler, has a capacity of 42 gallons, sufficient for three days' steaming.

The hull and engine are of the best material and workmanship. Water-tight compartments at bow and stern have sufficient buoyancy to prevent sinking in case the boat is filled with water. Twelve persons can be seated comfortably in the stern sheets.

In addition to steam power, the boat is provided with sliding gunter masts and sails, schooner rigged, and makes good speed under sail alone. It is cutter build, with square stern, weighs 5,500 pounds, and has a speed of 8 knots.

STEAM GIG.

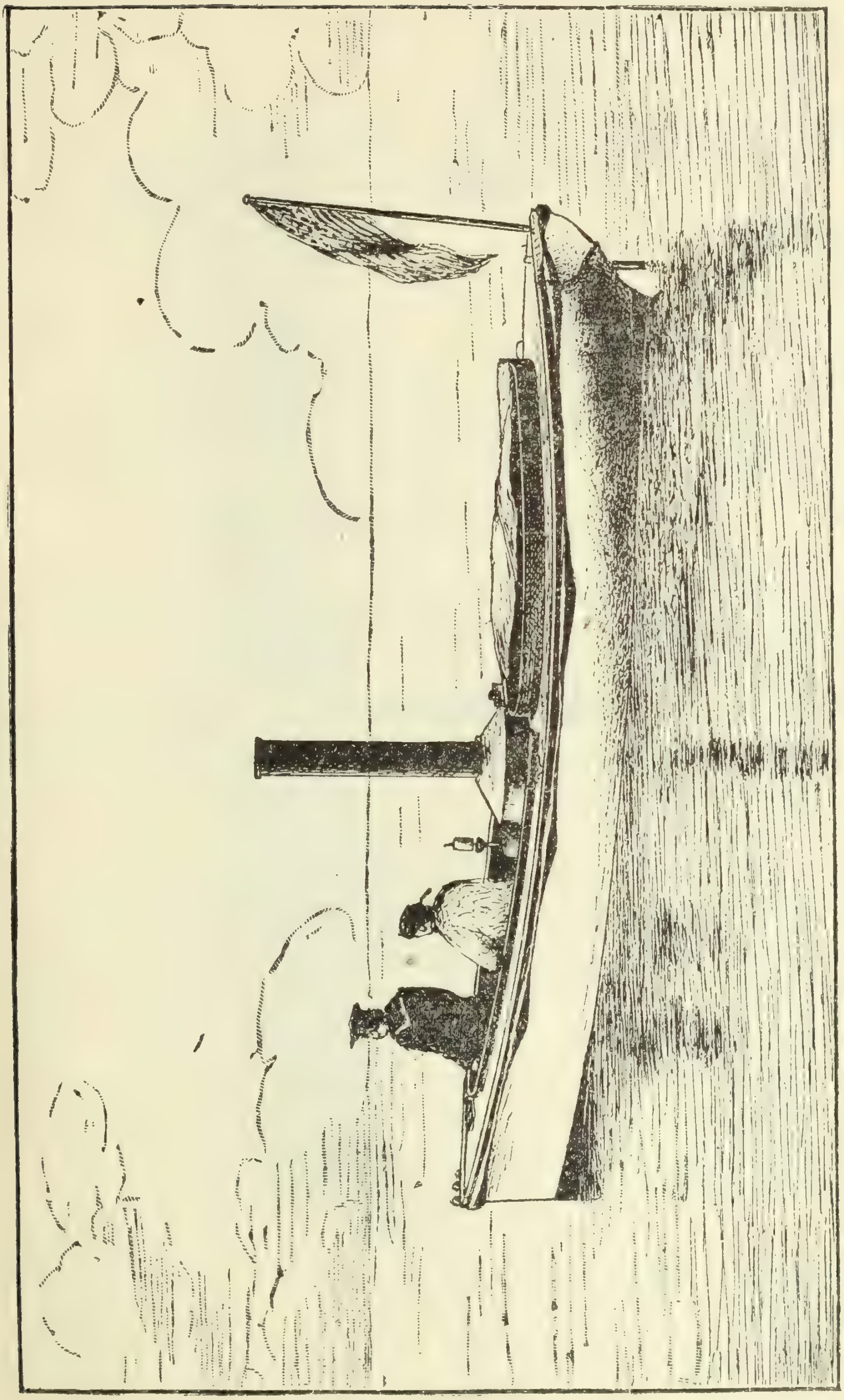
Built also by the Herreshoff Manufacturing Company. Twenty-five feet in length, 5 feet 2 inches beam, 3 feet $3\frac{1}{2}$ inches depth. A single coil boiler, compound engine, $4\frac{1}{4}$ inches and $2\frac{1}{2}$ inches diameter of cylinders, and 5-inch stroke, developing $7\frac{1}{2}$ horse-power with 100 pounds of steam.

It has the general form of a whale-boat, is double planked, spruce inside running diagonally, and mahogany outside running fore and aft. Both layers are bound together by brass screws at short intervals, making the structure unusually strong and light. There are water-tight compartments at bow and stern of sufficient capacity to float boat and crew in case it is filled with water. The total weight is 2,650 pounds.

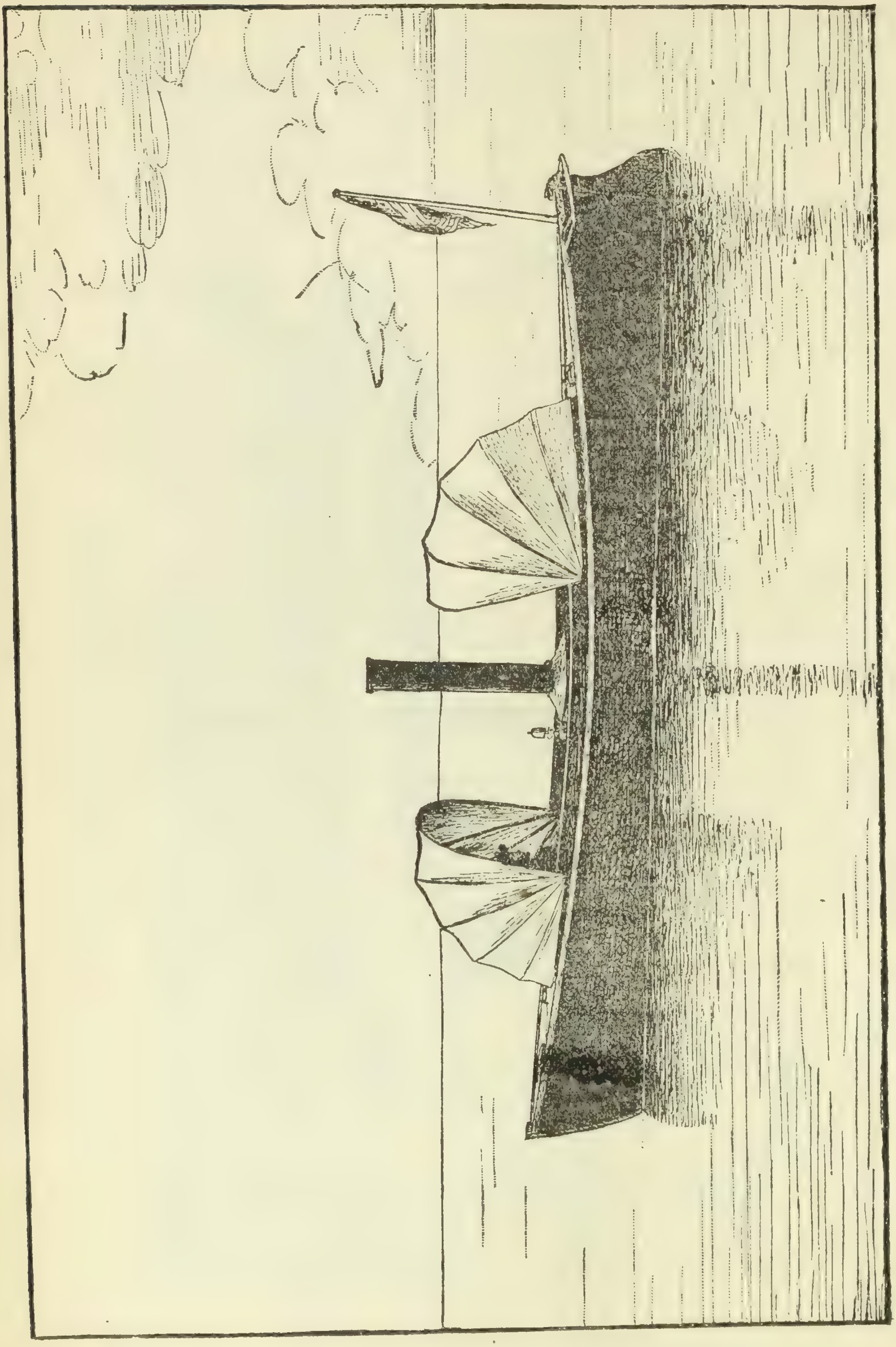
The bunkers hold 450 pounds of coal, and the fresh-water tank under the boiler carries 15 gallons, enough for two days' steaming. The ordinary speed of the boat is about 7 knots, although it can be driven to 8 for a short time. Seven persons can be seated comfortably in the stern sheets.

The location of the propeller under the bottom, about half the length from the stern, is a peculiar feature of this boat. It is so arranged that by a universal joint in the shaft the propeller can be hoisted and lowered, and when in the former position it does not project below the keel. When in use it is lowered, and no matter how heavy the sea, it is always submerged; thus racing is entirely avoided. The advantages of this system are not particularly apparent in smooth water, but her performance in a sea-way is remarkable. The gig is provided with a sliding gunter mast and sail, and makes good time under sail alone.

Steam can be raised in both cutter and gig in from three to five minutes.



HERRESHOFF STEAM CUTTER.



HERRESHOFF STEAM GIG.

SEINE-BOAT.

Built by Higgins & Gifford, Gloucester, Mass. Square stern, 28 feet in length, 7 feet 3 inches beam, 2 feet 6 inches in depth, and weighs 1,250 pounds. It pulls eight oars, and is schooner rigged, with sliding gunter masts. This boat is very light, and is designed especially for mackerel seining.

WHALE-BOAT.

Built at the navy-yard, Washington, D. C. Twenty-six feet in length, 5 feet 6 inches beam, 2 feet 3 inches depth. Pulls six oars, and weighs 780 pounds. Schooner rigged, with sliding gunter masts. This is an excellent boat, built with unusual care.

DINGHY.

Built at the Washington navy-yard. Eighteen feet 2 inches in length, 5 feet 6 inches beam, 2 feet 1 inch in depth, and pulls three pairs of sculls; weight, 550 pounds; rig, split lug-sail. The dinghy was also built with unusual care, and has done excellent service.

BOAT-DETACHING APPARATUS (PLATE XII).

The whale-boat and dinghy are kept hanging at the davits ready for emergencies, and are provided with a unique detaching apparatus, the invention of Midshipman (now Lieutenant) William Maxwell Wood, U. S. N.

The object of a detaching apparatus is to disengage both ends of a boat from the tackles at the same time, the operation being under the control of one man. To accomplish this Mr. Wood has provided a pair of links, L, Plate XII, Figs. 3 and 4, which oscillate freely about a center of motion. The form of this link is such as to permit the spherical toggle T to pass between its sides; now, if the link is pulled down by the chains rr', and the ends of the chains connected by the slip hook h, the toggle will slide up in the link and be locked in the narrow space between its sides, as shown in full lines in Figs. 1, 3, and 4. If, however, the slip hook h is tripped by pulling the lanyard a, Figs. 1 and 2, both chains rr' will be slacked, and the links L released to fly up into the positions shown by the dotted lines in Fig. 1, releasing the toggles and thus detaching the boat.

The locks g are provided as a measure of safety to prevent the toggles from slipping out of the links in case one end of the boat is hoisted faster than the other, or a fall is accidentally let go; in fact they prevent either end from being detached until the links are released by pulling the lanyard a.

This simple apparatus has been in constant use, at sea and in port, under all conditions of wind and weather, and has answered its purpose admirably without a single failure or accident.

THE RUDDER AND STEERING GEAR.

The Albatross was designed to perform much of her work stern to wind and sea, making it necessary to give unusual attention to the rudder and its appointments. The several parts are much heavier and stronger than usual in vessels of her size, and the appliances for controlling its movements are more powerful than will be found in steamers of twice her tonnage.

RUDDER ATTACHMENTS.

There is a yoke, or quadrant, on the rudder-stock a little below the spar-deck beams, carrying the chains to which the steel wire tiller-ropes are connected; an iron tiller on the poop deck, and a yoke for a powerful screw steering-gear on the upper extremity of the stock, also on the poop deck. Projecting from the rudder is a short tiller to which are attached the rudder chains ordinarily carried by steamers.

HIGGINSON & CO.'S STEAM QUARTERMASTER.

This admirable steering gear is located in the pilot-house (Plate VI), and is operated either by hand or steam, the change from one to the other being effected in a few seconds without interfering with the control of the helm. The same wheel is used in either case, and a spoke has the same effect on the rudder in both cases. The fact that very little exertion is required when steam is used is the only indication the helmsman has that he is not steering by hand.

A chain passes over the chain-wheel, which is fitted to take the links, to prevent slipping, and the terminals of the chain are attached to the steel wire tiller-ropes which run aft under the spar-deck beams and connect with the chains on the yoke.

This apparatus is very compact, and has performed its work in a thoroughly satisfactory manner, without accident or cost for repairs. It was furnished by the Pusey and Jones Company, Wilmington, Del.

AUXILIARY STEERING-GEAR (PLATE XIII).

This powerful screw gear is used when it is necessary to put the vessel stern to a heavy sea, as in sounding and dredging, and is designed to hold the rudder rigidly, thus relieving the ordinary steering-gear from unusual strains. Fig. 1 is a longitudinal elevation, and Fig. 2 a plan view of the apparatus. The yoke *c* is keyed to the upper end of the rudder-stock *f*, and the arms *d*, which have a screw-thread at one extremity working on the right and left hand screw-shaft *i*, and a hole in the opposite extremity for the reception of the pins *a*, are the means of connection between the yoke *c*, the screw-shaft *i*, and the steering-wheel *l*.

The arms *d* are held in a horizontal position by the guide-rod *e*, which is supported by the adjustable bearings *k*, which also carry the screw-shaft.

To disconnect the gear, remove the pins *a* from the arms *d* and the slots *b*, when the rudder will move freely.

SPARE TILLER.

Fig. 1 shows the spare tiller *g* keyed to the rudder-stock *f*. The eyebolts *h* for the relieving tackles slide along the whole length of the tiller, for convenience in hooking in case of accident to the steering-gear.

RUDDER-CHAINS.

The rudder-chains are shackled to the short tiller projecting from the rudder, seized to an eyebolt in the stern, and carried along the quarters in the usual manner.

THE ALBATROSS DREDGING.

Plate I represents the Albatross in the operation of dredging at sea. The vessel is backing with her stern to the wind, as indicated by the forward trend of the dredge-rope, flags, &c. In prosecuting this work it is necessary to maneuver in such a manner that the drift will be from the dredge-rope, thus preventing it from drawing under the vessel's bottom. If steel wire rope is used for this purpose it will also be necessary to keep it under tension, for if allowed to slacken, even for a moment, it will kink, thus reducing its tensile strength about 50 per cent. Before putting the trawl or dredge over, then, we must decide in what direction it can be dragged to the best advantage. Working in a uniform depth of water this would naturally be toward the position in which the next haul was to be made; but when operating on a steep slope, such as will be encountered off our coast, an uphill drag is the only one offering a fair probability of success. If the wind is blowing in the direction of the down slope, we would turn the vessel's stern to it and back the engine, but if the breeze should be from the opposite direction this could not be done. We would then go ahead, keeping the wind more or less on the starboard side, from which the dredge is lowered. The range of direction is, of course, much greater under the latter conditions, as the vessel is under control of the helm.

Ocean currents serve to complicate in no small degree the work of deep-sea exploration. A surface set is quickly detected and guarded against or utilized in prosecuting the work; but when the rope is suddenly swept under the bottom by a submarine current, with perhaps thousands of fathoms of line out, it requires a great deal of tact and patience to clear it from the ship and land the trawl on the bottom without capsizing it or kinking the rope.

The Albatross is represented at work under the most favorable conditions, the trawl lowered from the starboard side, and the starboard engine backing slowly. This has the tendency to keep the wind a little on the starboard quarter, thus drifting the vessel away from the rope, which is seen to trend somewhat off the bow.

The greatest advantage to be derived from backing while dredging, is that in case the apparatus fouls on the bottom a stern-board can be checked and the strain on the dredge-rope relieved more quickly than when steaming ahead.

C.—STEAM MACHINERY AND MECHANICAL APPLIANCES.

By Passed Assistant Engineer G. W. BAIRD, U. S. N.

The designs and specifications of the motive engines, as well as the hull, were drawn by the distinguished engineer, Mr. C. W. Copeland, of New York, and they were built by the Pusey and Jones Company, of Wilmington, Del. There is a two-cylinder compound engine for each of the two propellers; the engines are independent, and are provided with steam reversing gears; they are upright but not vertical, the cylinders inclining towards each other (Plate XV) to give more room on the working platform. There is one condenser, common to both engines, which is mounted on a bed-plate, and which forms the framing and cross-head guides for the engines; the single bed-plate supports the pillow-blocks of both engines. The condenser is of the type known as "surface condenser," and is arranged in three nests of horizontal tubes, the water passing successively through each nest, and the steam is condensed on the outside of the tubes.

There are two plunger air-pumps, placed horizontally, forward of the main engines, one plunger being worked from a concentric on the forward end of each crank-shaft. Both pumps are in one casting. The feed-pumps are worked from rods extending from the air-pump plungers.

The valves of the high-pressure cylinders are locomotive slides, over which gridiron cut-off valves are placed, while the low-pressure valves are double ported and are without cut-offs. All these valves are actuated by eccentrics and Stephenson links, in the usual manner.

The engines are provided with a system of valves by which they may be converted from compound to single expansion or simple engines.

There are two outboard deliveries, one for the circulating water and one for the air-pump or fresh water.

The circulating pump is a Davidson light-service pump, No. 26. (Plate XVII.)

There is a flexible coupling connecting each crank shaft to its line-shaft, and the thrust-bearings are on the line-shafts.

The screw-propellers are right and left, with four blades each, the blades curving radially and axially, according to the style of the designer.

The shaft-brackets are of wrought iron; one is placed near the hub of the screw and the other half way between this and the hull. The journals of the bracket are lined with bronze and lignum-vitæ, and the shaft in these journals is covered by a bronze jacket in the usual way.

The stern pipes are of cast iron, the after floors bored to receive them, and the frames bent round them. The stern bearings are also of cast iron, with flanges fitting the hull; they are 3 feet 4 inches in length, lined with lignum-vitæ staves, and are recessed to receive the stern pipes; the usual stuffing-boxes are provided.

The sea-valves are of bronze with bronze stems, seats, and glands, with cast-iron chambers, and have outside threads.

The principal dimensions of the engines are as follow:

Number of cylinders to each engine		2
Diameter of the high-pressure cylinders	inches	18
Diameter of the high-pressure piston-rods	do	3
Net area of the high-pressure cylinders	do	250.93
Clearance of the high-pressure piston	do	.5
Length of the steam-port of the high-pressure cylinder	do	13.5
Breadth of the steam-port of the high-pressure cylinder	do	1.75
Area of the steam-port of the high-pressure cylinder	do	23.625
Length of the exhaust-port of the high-pressure cylinder	do	13.5
Breadth of the exhaust-port of the high-pressure cylinder	do	3.5
Area of the exhaust-port of the high-pressure cylinder	do	47.25
Number of ports in the cut-off valve		3
Length of the ports in the cut-off valve	inches	13.5
Breadth of the ports in the cut-off valve	do	.875
Aggregate area of the cut-off valve ports	square inches	35.4375
Diameter of the low-pressure cylinders	inches	34
Diameter of the low-pressure piston-rod	do	3.5
Net area of each low-pressure cylinder	do	903.11
Stroke of all the pistons	do	30
Clearance of the low-pressure pistons	do	.5
Length of the steam-ports of the low-pressure cylinders	do	20
Breadth of the two steam-ports of the low-pressure cylinders	do	3
Area of the double steam-port of the low-pressure cylinders	do	60
Ratio of the volume of displacement of low-pressure piston to that of the high-pressure piston, per stroke		3.599
Length of pistons, on line of axis, at the circumference	inches	6
Thickness of metal in all the cylinders	do	1
Length of packing-rings on the high-pressure pistons	do	4.5
Length of packing-rings on the low-pressure pistons	do	3.75
Diameter of each (single-acting) air-pump plunger	do	16
Stroke of air-pump plungers	do	13.5
Displacement of each air-pump plunger per stroke	cubic inches	2,814.84
Diameter of each feed-pump plunger	inches	4.5
Stroke of each feed-pump plunger	do	13.5
Displacement of each feed-pump plunger per stroke	cubic inches	214.7
Diameter of the steam cylinder of the circulating-pump	inches	14
Diameter of the steam piston-rod of the circulating-pump	do	2
Net area of the steam piston of the circulating-pump	cubic inches	152.3
Diameter of the water piston of the circulating-pump	inches	16
Diameter of the water piston-rod of the circulating-pump	do	2
Net area of the water piston of the circulating-pump	square inches	199.49
Stroke of the pistons of the circulating-pump	inches	14
Ratio of the area of steam piston to that of the water piston		1:1.308
Number of brass tubes in the condenser		2,394
Outside diameter of the condenser-tubes	inch	.625
Exposed length of the condenser-tubes	inches	66
Condensing surface of the tubes	square feet	2,142
Number of crank-shaft journals to each engine		3
Diameter of the forward journal	inches	7
Diameter of the middle journal	do	8.5
Diameter of the after journal	do	8.5
Length of the forward journal	do	8.5
Length of the middle journal	do	16
Length of the after journal	do	13.5

	Ft.	In.
Diameter of the high-pressure crank-pins		$5\frac{3}{4}$
Length of the high-pressure crank-pins		$7\frac{1}{2}$
Diameter of the low-pressure crank-pins		$7\frac{1}{4}$
Length of the low-pressure crank-pins		9
Diameter of the high-pressure cross-head pins		3
Length of the high-pressure cross-head pins		$4\frac{1}{2}$
Diameter of the low-pressure cross-head pins		$3\frac{1}{2}$
Length of the low-pressure cross-head pins		5
Diameter of the line-shafts (wrought iron)		8
Length in the vessel occupied by the engines	9	4
Breadth in the vessel occupied by the engines	15	6
Height of the engines above center line of shafts	12	6

The following is a list of the weights of the main engines:

CAST IRON.

	Pounds.
2 condenser covers	2,738
1 condenser	12,010
4 cylinders	14,820
1 bed-plate	15,412
2 "pinch-wheels" (couplings)	3,210
2 "crank-wheels" (couplings)	3,270
4 slide-valves	1,568
1 double air-pump and bed	2,750
4 steam-chests	2,520
4 steam-chest covers	2,084
10 eccentrics	1,188
4 pistons	1,586
4 line-shaft couplings	2,130
12 thrust-collars	2,260
4 cylinder-heads	2,509
2 stern-bearings	4,897
2 thrust-bearings	2,655
2 throttle-valve chambers	448
2 screw-propellers	8,076
2 stern-pipes	1,376

BRONZE CASTINGS.

4 tube sheets (condenser)	4,098
2 stern-bushings	257
2 shaft-bushings	663
2 air-pump plungers	1,030
6 link-blocks	101

PHOSPHOR-BRONZE CASTINGS.

6 lower boxes for crank-shaft	836

IRON FORGINGS.

2 shafts	19,043
4 hangers	5,480
4 connecting-rods	2,266
4 straps, gibs, and keys	654
4 double-cranks	7,680
4 crank-pins	990
4 coupling-pins	764
6 valve-stems	590
5 links	786

	Pounds.
Air-pump connections	1,071
Levers and arms	731
Guides	843
12 eccentric rods	1,202
4 "cylinder braces" (struts)	1,104
Link connections	295
STEEL FORGINGS.	
4 piston-rods	1,877
BRASS TUBES.	
2,400 drawn-brass condenser-tubes	4,972
COPPER PIPE.	
Steam, feed, and blow pipes	3,458
REVERSING GEAR.	
2 steam cylinders, valves, guides, rods, arms, &c	2,276
CIRCULATING-PUMP.	
1 Davidson light-service pump, No. 26	2,600
ADDITIONAL WEIGHTS.	
Floor-plates, flanges, cast-iron exhaust-pipes, bolts, nuts, &c., used in fitting up	48,017
No. 5 Davidson pump	1,100
No. 5 Davidson light-service pump	900
Total weight of motive engines	203,192

BOILERS.

There are two return-flue boilers (see Plate XVI) having a half steam drum and half chimney each; they are placed fore and aft in the hold of the vessel, side by side, with the fire-room athwartships and at the after end of the boilers. The axis of the chimney cuts the center plane of the ship, and is between the boilers. The two half chimneys are divided by a $\frac{3}{8}$ inch wrought-iron plate, riveted to both, so that the draught of one boiler is not affected by the other. Each boiler has its stop-valves, feed and blow valves, checks, whistle-valves, steam and water gauges, and damper complete. The boilers are covered with hair felting to retard radiation. The crown-sheets and flue sheets are of steel; all other portions of the boilers are of wrought iron. The flues are seamless, drawn, the flue sheets being flanged to receive them. The boilers are set in cast-iron chairs, and are provided with cast-iron ash-pans.

The principal dimensions of the boilers are as follow:

Number of boilers		2
Diameter of waist	feet..	$8\frac{1}{2}$
Length of boilers	do ..	$21\frac{1}{4}$
Number of furnaces to each boiler		2
Width of furnaces	inches..	$43\frac{1}{2}$
Length of grate bars	feet..	$6\frac{1}{4}$
Aggregate area of grate surface in both boilers	do ..	$95\frac{1}{4}$
Number of 15-inch flues in each boiler		2
Number of 12-inch flues in each boiler		2
Number of 11-inch flues in each boiler		6
Number of 9-inch flues in each boiler		16

Length of the 15, 12, and 11-inch flues .... feet..	10
Length of the 9-inch flues .... do..	16¾
Diameter of the complete chimney .... inches..	52
Height of the chimney above the grates .... feet..	46
Aggregate area, for draught, over the bridge-wall in both boilers, in square feet	18.16
Aggregate area through the lower flues of both boilers .... square feet..	13.962
Aggregate area through the back connections for draught in both boilers .... square feet..	26.791
Aggregate area through the upper flues of both boilers .... do....	14.157
Cross-area of smoke-pipe .... do....	14.700
Aggregate heating surface in the furnaces of both boilers .... do....	224
Aggregate heating surface in the lower flues of both boilers .... do....	440.836
Aggregate heating surface in the upper flues of both boilers .... do....	1,281.614
Aggregate heating surface in the combustion chambers of both boilers .... square feet..	116
Aggregate heating surface in the back connections of both boilers, square feet	304
Aggregate heating surface in the front connections of both boilers, square feet	112
Total water-heating surface in both boilers .... square feet..	2,478.5
Total superheating surface in both boilers .... do....	204
Ratio of grate to cross-area over bridge-walls	5.429:1
Ratio of grate to cross-area through lower flues	6.828:1
Ratio of grate to cross-area through back connection	3.558:1
Ratio of grate to cross-area through upper flues	6.743:1
Ratio of grate to cross-area through chimney	6.485:1
Ratio of water-heating surface to grate-surface	26:1
Height of the center of the steam-pipe opening above the normal level of the water in the boilers .... feet..	11.5

The weights in the boilers are distributed as follow:

	Pounds.
Wrought-iron and steel in the shells of both boilers	62,971
The flues in both boilers	18,425
Braces in both boilers	10,420
Rivets, socket-bolts, manhole plates, &c	14,618
Safety-valves, stops, checks, ash-pans, and floor-plates	14,394
Smoke-pipe, cape, and casing	3,599
Weight of water in both boilers	69,197

There are two screw-propellers, one right and one left, of cast iron, the blades curving backward, the edges curved, the forward or leading corner being curved to a radius of 17 inches, and the trailing corners curved to a radius of 16 inches. The length of the blades, on the line of the axis of the screws, is from 23 to 26 inches. The principal dimensions are as follow:

Diameter .... feet..	9
Greatest diameter of the hub .... inches..	17½
Pitch (uniform) .... feet..	14⅚
Number of blades, each	4
Fraction of the pitch used, from	0.2696 to 0.5898
Helicoidal area of each screw .... square feet..	42.02
Thickness of blades at fillet of hub .... inches..	4¼
Thickness of blades at periphery .... do....	¾
Weight of each screw .... pounds..	4,038

THE POWER, ITS DISTRIBUTION AND THE SPEED OF THE SHIP.

The nature of the service of the ship is such that uninterrupted voyages of considerable length seldom occur, and as errors in experiments are principally in the beginning and ending, it follows that short tests must be less reliable than long ones. For this reason I determined to select one of our longest uninterrupted voyages, when the vessel's bottom was clean and when she was near her average draught of water for steaming. This opportunity occurred about seven months after the ship had been put in commission, the voyage being from the New York navy-yard to the Washington navy-yard. The coal used was anthracite, containing more than the average percentage of ash and clinker. The fires were not urged, there being no desire to make a quick voyage, so that the performance must be considered as the average and not the maximum. The wind was light but ahead; the sea was smooth.

Duration of voyage ... hours..	$42\frac{1}{6}$
Total distance, in geographical miles of 6,086 feet	423
Mean number of geographical miles per hour	10.03
Total number of revolutions of the starboard engine	200,197
Total number of revolutions of the port engine	200,411
Mean number of revolutions per minute of the starboard engine	79.05
Mean number of revolutions per minute of the port engine	79.06
Slip of the starboard screw in per cent of its speed	14.74
Slip of the port screw in per cent of its speed	14.75
Mean steam-pressure in the boilers in pounds per square inch above the atmosphere	60.05
Mean pressure per square inch above zero in the starboard receiver	25.53
Mean pressure per square inch above zero in the port receiver	23.78
Mean vacuum in the condenser, in inches of mercury	24.46
Mean height of the barometer, in inches of mercury	30.09
Mean position of the throttle-valves, in eighths	7.20
Mean point of cutting off in the starboard high-pressure cylinder, in inches	26.333
Mean point of cutting off in the starboard low-pressure cylinder, in inches	14.032
Mean point of cutting off in the port high-pressure cylinder, in inches	19.78
Mean point of cutting off in the port low-pressure cylinder, in inches	17.831
Total number of pounds of coal (anthracite)	42,865
Total number of pounds of ashes, clinkers, &c	8,353
Total number of pounds of combustible	34,512
Mean number of pounds of coal per hour	1,016.97
Mean number of pounds of combustible per hour	818.79
Percentage of refuse in coal	19.40
Mean number of pounds of coal per hour per square foot of grate surface	10.667
Mean number of pounds of coal per hour per square foot of heating surface	0.4103
Mean number of pounds of combustible per hour per square foot of grate surface	8.598
Mean number of pounds of combustible per hour per square foot of heating surface	0.3303
Mean number of strokes per minute of the circulating-pump	80
Mean temperature of the external atmosphere	73.73
Mean temperature of the injection-water	65.73
Mean temperature of the discharge-water	93.78
Mean temperature of feed-water	76.39
Mean temperature of the engine-room	119.10

HORSES-POWER.

Indicated horses-power developed in the starboard high-pressure cylinder	93.460
Indicated horses-power developed in the starboard low-pressure cylinder	122.240
Indicated horses-power developed in the port high-pressure cylinder	110.224
Indicated horses-power developed in the port low-pressuro cylinder	131.602
Aggregate indicated horses-power developed in the starboard engine	215.700
Aggregate indicated horses-power developed in the port engine	241.206
Horses-power required to work the starboard engine	22.116
Horses-power required to work the port engine	22.118
Net horses-power applied to the starboard shaft	193.584
Net horses-power applied to the port shaft	219.708
Horses-power absorbed in friction of the load on the starboard engine	14.519
Horses-power absorbed in friction of the load on the port engine	16.478
Horses-power expended in the slip of the starboard screw	23.278
Horses-power expended in the slip of the port screw	26.838
Horses-power expended in friction of the starboard screw-blades and shaft on the water	21.278
Horses-power expended in friction of the port screw-blades and shaft on the water	21.279
Net horses-power applied to the propulsion of the hull	289.642

DISTRIBUTION OF THE POWER.

Percentage of the net power applied to the shafts absorbed in friction of the load	7.500
Percentage of the net power applied to the shafts absorbed in the friction of the screw-blades, hubs, and shafts on the water	10.297
Percentage of the net power applied to the shafts absorbed in the slip of the screws	12.122
Percentage of the net power applied to the shafts utilized in the propulsion of the hull	70.081

ECONOMIC RESULTS.

Pounds of coal consumed per indicated horse-power per hour	2.222
Pounds of coal consumed per net horse-power per hour	3.246
Pounds of combustible consumed per indicated horse-power per hour	1.789
Pounds of combustible consumed per net horse-power per hour	2.613
Pounds of coal per mile	101.336
Pounds of combustible per mile	81.588

THRUST OF THE SCREWS.

The net power applied to the propulsion of the hull by the two propellers, being 289.642 horses, is equal to $(289.642 \times 33{,}000 =)$ 9,558,186 foot-pounds of work per minute, and, the speed being 10.03 knots per hour, is equal to $\left(\frac{10.03 \times 6086}{60} =\right)$ 1017.376 feet per minute; therefore, the resistance of the hull (and the equivalent thrust of the screws) at that speed was $\left(\frac{9{,}558{,}186}{1017.376} =\right)$ 9,395 pounds.

The thrust per indicated horse-power, at that speed, was $\left(\frac{9395}{457.526} =\right)$ 20.31 pounds, and per pound of coal per hour it was $\left(\frac{9395}{1016.97} =\right)$ 9.23 pounds.

POWER ABSORBED BY THE FRICTION OF THE WETTED SURFACES OF THE HULL AGAINST THE WATER.

Taking the resistance of the water to a square foot of smoothly-painted surface of the hull, moving at a velocity of 10 feet per second, to be 0.45 of a pound, and (according to the method of Chief Engineer Isherwood, U. S. N.) deducing from the speed of the vessel the mean speed of its immersed surfaces due to the inclination of the water-lines, there results a speed of 16.35076 feet per second and a consequent surface resistance of ($10^2 : 0.45 :: 16.35076^2 :$) 1.203063 pounds per square foot at that velocity. The aggregate wetted surface during the above-mentioned voyage was 7350.44 square feet, and the power expended in this resistance was $\left(\frac{7350.44 \times 1.203063 \times 16.35076 \times 60}{33000} = \right)$ 262.893 horses; consequently, of the 289.642 horses-power required to propel the hull, $\left(\frac{262.893 \times 100}{289.642} = \right)$ 90.73 per cent was expended in overcoming the friction of the hull on the water, and the remaining 9.27 per cent was expended in displacing the water and overcoming the pressure of the wind against the upper part of the hull, the spars, and the rigging.

SVEDBERG GOVERNORS.

In a heavy sea-way a ship, from excessive pitching, will sometimes throw the screw out of water sufficiently to relieve it of the resistance of the water; at such times the screw and engine, thus released, will spin around very rapidly, endangering the machinery. To prevent this it was formerly the custom to station a man at the throttle who would close that valve when the engine began to speed up (to "race"), and to open the throttle when the engine slowed down. This operation was never satisfactory, and gave birth to the invention of many marine governors, the majority of which were centrifugal in principle, and consequently depended on the speeding of the engine to close the throttle, or, in other words, to slow the engine after the racing had commenced. The object of the Svedberg governor is to anticipate the racing and to close the throttle-valve before it commences.

To accomplish this an air-chamber A, Plate XVIII, is placed at the stern of the ship, as low down as it can be fixed; the top of this air chamber is connected to the top of a mercury-cup by a pipe; this mercury-cup (B, Plate XVIII) is made on the principle of a Wolf jar, and besides mercury it contains a wooden float on the lower end of the rod *r*, which passes through the oblique cylinder *d* to the surface of the mercury; the cylinder, though in the same casting with the mercury-cup, has its lower rim immersed in the mercury. Any elevation of the stern of the ship, or any rise or fall of the water under the stern of the ship, will increase or diminish the pressure in the air-chamber A, which pressure is promptly communicated to the mercury-cup B, and depresses or lifts the surface of the mercury in the cup; but as the lower rim of the

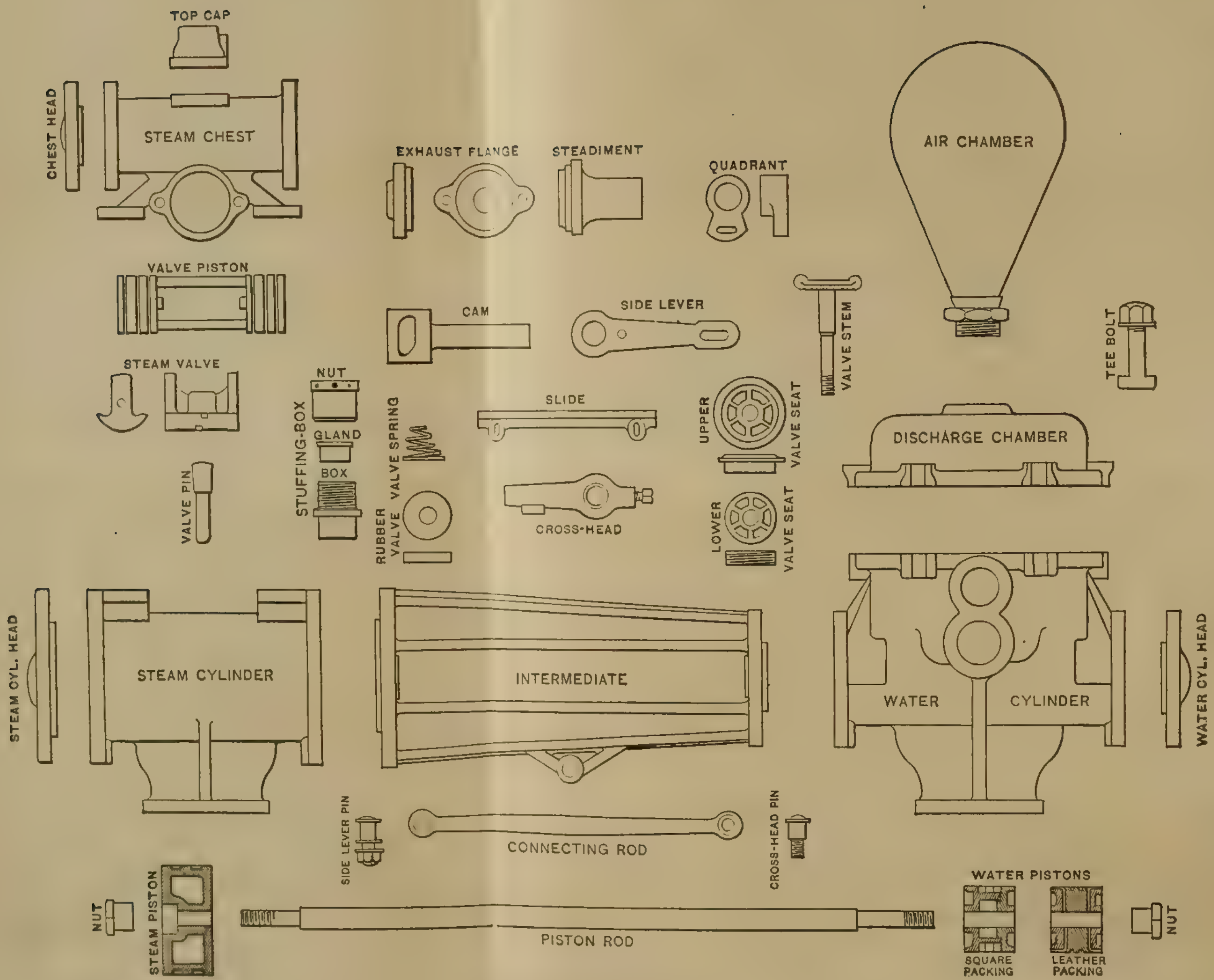
oblique cylinder *d* is immersed in the mercury, any rise in B will depress the mercury in *d*, and will cause the float (and rod *r*) to fall or rise accordingly; and this rise or fall is directly proportional to the pressure at the stern of the ship. The pressure exerted by the float is necessarily small, while the power required to move the throttle-valve is sometimes considerable, and for this reason a steam-engine is interposed, the float moving the valve of the little engine, while the pressure of steam in the little cylinder moves the throttle. In this engine the piston and rod are fixed, while the cylinder moves upon the piston; the valve chest and cylinder are cast in one, and the steam and exhaust pipes slide through stuffing-boxes; the cylinder is connected by the rod *e* to the throttle-valve lever. The action of the machine is as follows: The water, rolling from under the stern, causes a diminution of pressure in the air-chamber, which is transferred to the mercury-cup, lifts the float and rod *c*, and, through the levers (shown in the engraving), communicates a definite amount of motion to the valve; steam is thus admitted to the cylinder and moves it to the right until the motion of the cylinder has equaled that of the valve, when the ports are thus automatically closed, and the cylinder and throttle-valve come to rest. By changing the quantity of mercury in the cup, adjusting the length of the rods or throw of the levers, the throttle-valve can be made to come to rest at any desired position, or to work between desired limits. In practice the machine works admirably, surpassing the writer's most sanguine expectations.

STEAM PUMPS.

The Albatross is provided with three steam pumps, of the Davidson pattern, as follows:

Circulating pump, No. 26. Light service.
Boiler feed or fire pump, No. 5. Regular.
Hydrant pump, No. 5. Light service.

The circulating pump has a steam cylinder 14 inches in diameter of bore, a water cylinder 16 inches in diameter, and a stroke of piston of 14 inches. Its speed may be varied from 1 to 200 strokes per minute, its ordinary speed being about 75 strokes per minute. It is piped to pump from the sea or from the bilge, and to discharge into the condenser. Its maximum capacity is about 2,400 gallons of water per minute. The writer has indicated the pump at several speeds, and constructed a curve (Fig. 1) in which the length of the ordinates refers to the indicated horses-power and the abscissas to the interval between speeds. The power of the pump can be ascertained at any moment by counting the strokes per minute and referring to Fig. 1. The boiler



Face page 29.

FIG. 2.—Details of pumps.

WATER CYL. HEAD

feed or fire pump (Plate XXVI) is proportioned to work against great pressures; it is piped to take water from the sea or from the bilge, and to deliver to the boilers, to the hydrant pipe (which delivers water to hydrant connections on the side of the deck house, to the laboratory, the engine room, and fire room), to the ash-chute, or overboard, at pleasure. The steam cylinder is 9 inches in diameter, the water cylinder is $5\frac{1}{4}$ inches in diameter, and the stroke of piston is 12 inches. The maximum capacity of this pump is about 250 gallons per minute.

The hydrant pump has a 7-inch steam cylinder, a 5-inch water cylinder, and a stroke of piston of 10 inches. It is piped to take water from the sea or the bilge and will deliver it to the boilers, the hydrant pipe, the ash-chute, or overboard; its maximum capacity is about 200 gallons per minute.

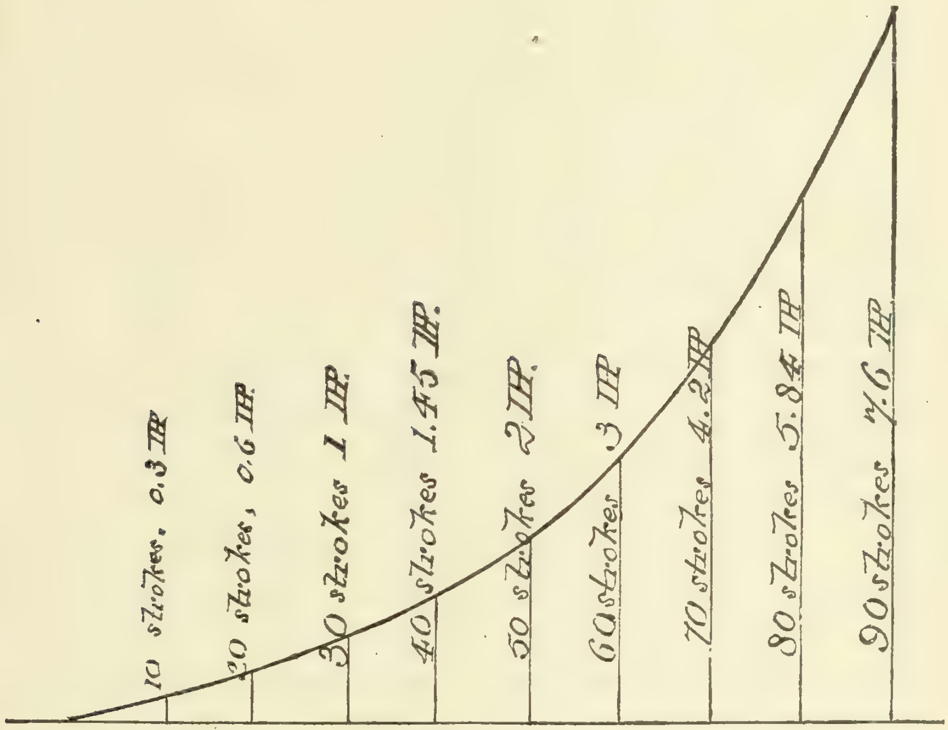


FIG. 1.

The three pumps are similar in design and in detail, differing only in size and proportion. Fig. 2 shows the details and commercial names of the parts.

The parts of the pumps are manufactured to gauges and are interchangeable; the water valves have unusually large openings; the steam valves have positive motion as well as being "steam thrown;" the water cylinders are brass lined, the valve seats and stems, glands, and piston rods are of brass. The working parts are quite accessible.

INJECTORS.

In addition to the pumps, two "Little Wonder" injectors are provided to feed the boilers. They take the water from the hot-well or from the sea and deliver only to the boilers. They are especially useful in feeding from the sea in cold weather, as they warm the water before

delivering it to the boilers. We have never succeeded in working both at a time, though they work very well singly, and it rarely occurs that we are obliged to use a steam-pump to feed the boilers.

ASH ELEVATOR AND CHUTE.

Plate XIX shows a half section of the vessel at the center line of the ash-chute, and Plate XX shows several views and sections of the hoisting engine. The object of this machinery is to hoist the ashes and dump them overboard with the least manual labor and to avoid carrying them across the deck. The vertical chute through the ship's bottom has been tried and abandoned, as the ashes soon scoured through the bottom plates of the ship, in the wake of the chute. The steam ejectors, tried in the navy, were abandoned for the reason that the ashes, blown at such a high velocity, very quickly scoured through a 2-inch thick cast-iron pipe; the writer, therefore, designed the diagonal tube (a 10-inch wrought-iron boiler flue) surmounted by a hopper, and the engine referred to. A stream of water ($1\frac{1}{4}$ inches in diameter) is projected into the hopper while ashes are being dumped, and the velocity of the descending cinders, though not great, is sufficient to project them quite clear of the ship's side. The hopper and elbow are of cast iron, and after two years' use they show scarcely any erosion. The principle of the engine is very old, it belonging to that class which is reversed by "changing the ports," *i. e.*, by having an arrangement by which the steam and exhaust ports are changed, the one for the other. For simplicity and fewness of ports the crank-shaft and hoisting drum are one and the same piece of cast iron; the cylinders are oscillating, their ports being in the trunnions, the motion of the cylinders opening and closing the ports; the steam-chest between the two cylinders is common to both, and has at its center a piston valve; steam enters through the end of the piston valve, and by moving this valve the steam goes to one side of the chest only; by moving the valve in the opposite direction the steam would go to the other side of the valve chest, which latter is divided, by a longitudinal diaphragm, into two compartments; the exhaust is through one side of the piston valve. By this arrangement it will be seen that when this piston valve is in its middle position no steam can pass into or out of the engine, which of course stops it; it is also manifest that a movement of the valve in one direction will cause the engine to run in one direction, and the opposite motion of the valve will reverse the engine. The piston valve is moved by a lever which has a long slot in it (*a*, Plate XX) through which the hoisting rope passes; on the rope there are two stops (knots), so situated that one will press and move the the lever when the bucket is up, and the other when the bucket is down. To operate the machine two men are employed; the first one fills the bucket and moves the lever, the bucket rises to its stop and is brought to rest; the second man dumps the bucket into the chute, pulls the

lever (by a cord not shown), when the bucket descends to the floor and is again automatically stopped. The machine is noiseless and rapid in its action, has worked with certainty, and has required but little attention.

DISTILLING APPARATUS.

The distiller, patented by the writer, is the kind generally used on board American steamships. The object of the machine is to distil drinking-water. There are three block-tin coils placed inside an annular cast-iron cylinder, the coils terminating in manifolds which pass through stuffing-boxes in the heads of the cylinder, as represented in Plate XXI. To the top of the coils is screwed an air-injector *a*, which is supplied with steam at *b* and air at *c*, the velocity of the steam inducing the air current; the steam and air thus entering, molecule to molecule, thoroughly mixed before condensation. The current of sea-water, forced into the condenser at *d*, passing out at *e*, keeps the surfaces of the coils cool which condense the steam within. The fresh water and air rush out of the coils at *f* and into a filter of *carbo animalis purificatus*, from which it is delivered to the ship's tanks through the opening *g*. The fresh water will absorb (dissolve) only a small portion of the air (less than 2½ per cent of the volume under the pressure of the atmosphere), but the large excess of air injected into the steam serves to oxidize organic matter which is brought over by the steam, and this especial filter is to remove those oxides. The object of the annular jet of steam is to bring a larger surface of steam-jet in contact with the air, and the object of the annular condenser is to compel the circulating water to flow over the condensing surface. The filtering material requires to be renewed about once in two years. The commercial size of this machine is No. 4, and its capacity is 2,000 gallons per day; the daily consumption of water on board is about 250 gallons. A ton of coal will distil about six tons of water, so there is a saving of weight and space by employing the distiller on board ship. The quality of the distilled water is always the same, and I quote the words of an eminent medical director of the Navy in saying that "diarrhea has diminished 50 per cent on board our ships since the introduction of distilled water." The water is clear and, being well aerated, tastes quite as good as hydrant water; in fact it is difficult to detect it as the product of distillation.

LIGHTING.

The operation of dredging, in great depths, sometimes carries the day's work past midnight, and after the contents of the dredge are safely deposited on board, the naturalists are required to preserve the specimens, which often takes two hours longer. To facilitate this the commissioner authorized the installation of the Edison incandescent system of electric lighting. The plant consists of an 8½ by 10 inch Armington

and Sims engine, an Edison Z dynamo (Plate XXII) having vertical field magnets, a resistance-box in the magnetic field-current, the necessary wiring, lamp fixtures, safety-catches, and lamps.

THE ENGINE.

The steadiness and uniform brilliancy of the lamps depends so largely on the engine driving the dynamo that Mr. Edison has adopted the best (though quite expensive) engine he could find, which is manufactured at Providence, R. I., by Armington & Sims. The great success of this engine lies in the correct balancing and lightness of its working parts, large bearing surfaces, early exhaust closure, and in its extremely sensitive governor. It has a piston valve, which has considerable exhaust lap, which serves not only to "cushion" the piston past its centers but to save the steam thus compressed in the clearance spaces. The engine runs 300 revolutions per minute, and is belted to and drives the dynamo 1,200 revolutions per minute. The governor of the engine is fixed in the fly-wheel,

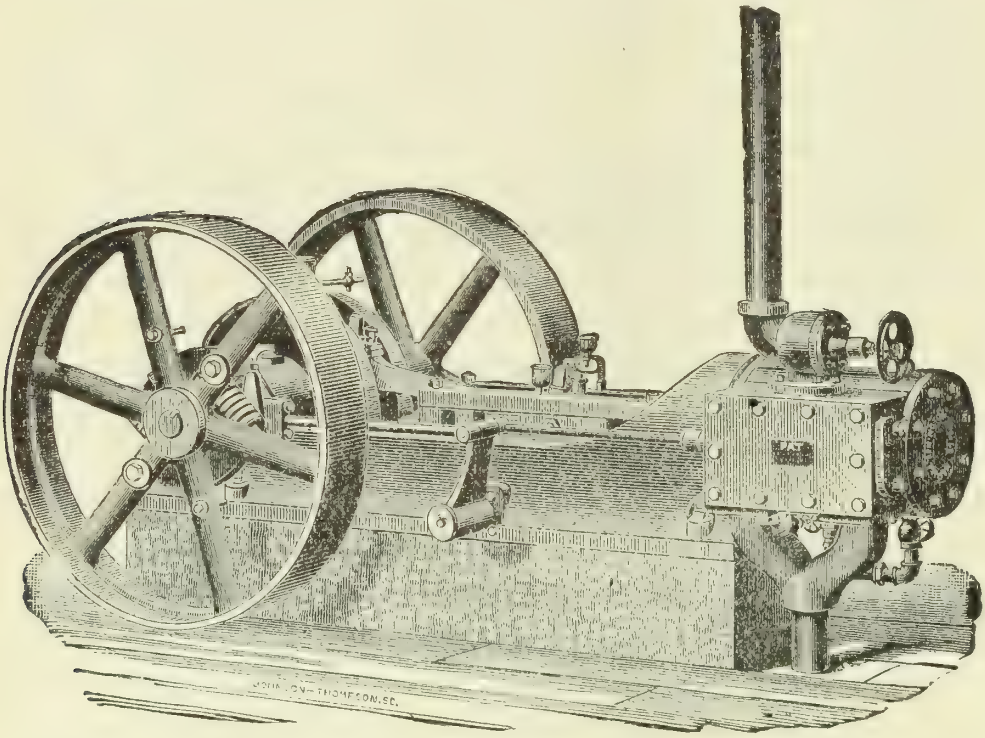


FIG. 3.

which is keyed to the shaft; there are two eccentrics, one within the other, and both movable on their axis; there are two weights, with their centers of motion opposite, and fixed in arms of the wheel; these weights are each connected to one of the eccentrics and connected by an arm or rod; spiral springs (Fig. 3), to resist the centrifugal force of the weights, are provided; the system is so constructed that any centrifugal motion of the weights will throw one eccentric ahead and the other back, thus diminishing the throw of the eccentrics and effecting a shorter cut-off, without changing the lead of the valve. When the main engines of the ship are in motion, we use a boiler pressure of 50 pounds above the atmosphere and exhaust all engines (including the dynamo engine) into

the condenser, where there is from 23 to 26 inches of vacuum; lying in port, we let the boiler pressure fall to 25 pounds and exhaust the dynamo engine against pressure of the atmosphere; and notwithstanding this great difference of pressure between the two conditions, the governor of the dynamo engine so regulates the quantity of steam to the cylinder that the revolutions of the engine remain practically at 300, never varying more than 2 per cent. The engine and the dynamo are run by enlisted men in the engineers' department.

THE DYNAMO.

The dynamo (Fig. 4) is of the size known as Z, and is wound for what is called a B circuit, *i. e.*, a circuit which will give 51 volts of electromotive force, and generate a current for 120 lamps, each requiring 0.745 amperes, offering a resistance of 69 ohms. The field magnets are

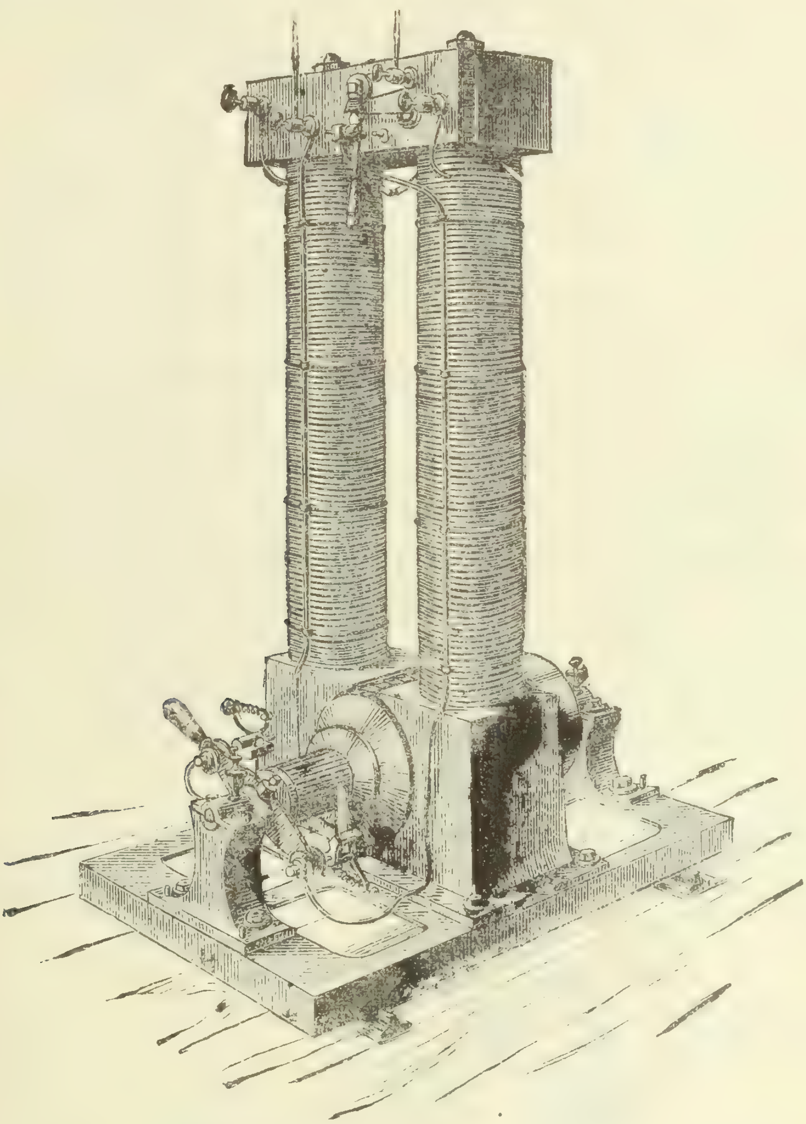


FIG. 4.

vertical, and the armature revolves on a horizontal axis, in the magnetic field. The field magnets are arranged on what is called a "derivation" or "shunt" from the commutator, placing it in the circuit as in the Siemens system. In adapting and utilizing known principles and devices and in patiently working out details, Mr. Edison has brought his system of lighting to an admirable state of perfection; wherever the eye rests

it is pleased by correct proportions, sound mechanical principles, and agreeable outlines.

To preserve the uniformity of the current an adjustable resistance-box is placed in the field circuit, so that when a number of lamps are extinguished additional resistance may be thrown into the field by a switch on the resistance-box, whereby the internal and external resistance may be balanced, preserving not only the uniform brightness of the lamps, but also the economy of the machine.

THE WIRING.

The wires are all of copper; those well protected from dampness are insulated with a woven cotton and white lead covering; where they pass damp or wet places they are further incased in rubber tubes; where they pass hot places (through the boiler room) they are run through lead tubes; and where they pass through iron bulkheads they are protected by hard-rubber tubes. There are two complete circuits round the ship; in the event of an accident to one circuit (by collision, for example) the lamps will be fed by the other. These main circuits, on board ship, are necessarily doubled or even tripled, as the short bending of a large wire or rod, or hauling it through holes in iron or wood, would be apt to injure the insulation besides increasing the labor. No. 10 is, therefore, the largest wire, and No. 20 the smallest wire used in our circuit.

Where a wire—main wire or branch—passes along a surface of iron, as a lodger plate, it is fitted in a groove in a wooden batten, and never permitted to touch the iron; when it passes a wooden surface, a groove is cut to let it in, and it is puttied and painted over; wherever possible the wires are led out of sight. Wherever splicing or tapping of wires was necessary, the ends were cleared of the insulation, cleaned with sand-paper, soldered, and recovered with a bituminous mixture called "insulation compound," and finally tightly covered with tape; these joints are thus as well protected as any part of the wire.

LAMP FIXTURES.

The lamp fixtures are designed to suspend above and cast the unobstructed rays of light downward. Handsome brass fixtures with por-

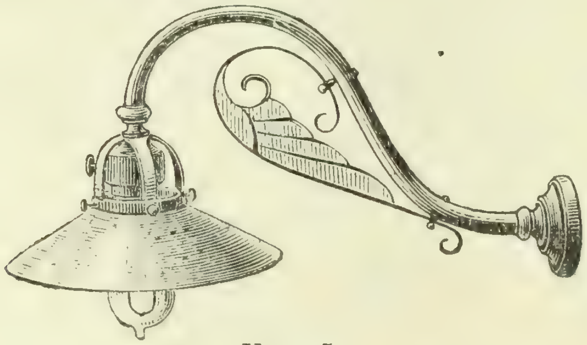


FIG. 5.

celain shades of three kinds are used on board. Fig. 5 is called a bracket, Fig. 6 a single-swing bracket, and Fig. 7 a double-swing bracket.

The wires are run through the tubes of these brackets, but in the joints of the swinging brackets the current is transmitted through insulated hinges, to which the wires are fixed by binding screws, as shown at *a* in Fig. 8, by which arrangement the wires are not twisted in swinging the bracket. The wires are brought to the binding posts in the lamp-socket, Fig. 9, between their binding screws and brass conductors; one of these brass conductors is soldered to the thin-spun brass socket into which the lamp is screwed while the other is connected, through the key, to a brass disk placed centrally in the bottom of the socket, against which one pole of the lamp presses when screwed in place. The key is mounted on a screw-thread of such pitch that one-fourth of a revolution will give it sufficient axial motion to open or close the circuit. The small number of parts used in these fixtures, their correct proportions, the adaptation of their forms to machine tool manufacture, and their beauty of design excite the admiration of both artists and mechanics.

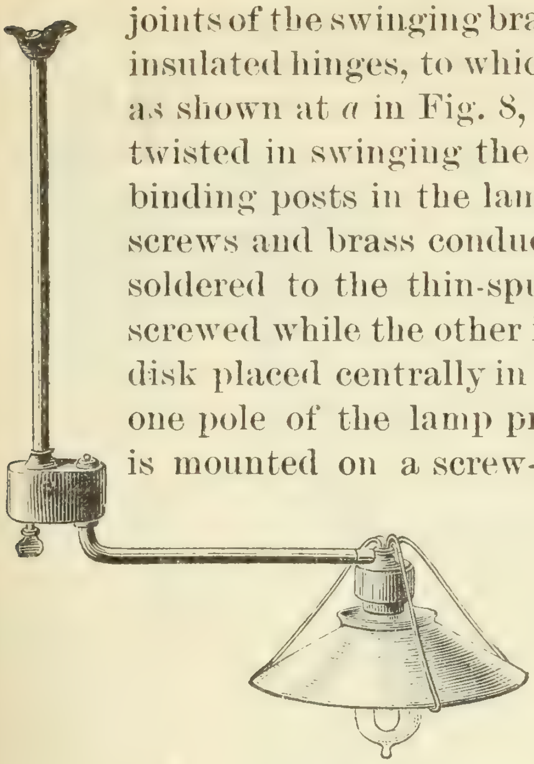


FIG. 6.

THE LAMPS.

The lamps are of thin glass, pear-shaped, containing a thread of bamboo carbon about as thick as a horse-hair. The small end of the lamp (Fig. 10) contains glass of sufficient thickness to make a tight joint on the platinum wire conductors which carry the current to the carbon. The atmosphere is exhausted by Edison's modification of the Sprengel pump, through a tube at the lower end of the lamp, and the tube is then fused and broken off. Platinum wire is used because its index of expansion is the same as that of glass, thus preventing any breakage or leakage from the heat. The bamboo-carbon, and platinum wire are soldered together by electrically-deposited copper. One wire, passing through the glass, is soldered to a small brass disk which is centered on the top of the lamp (Fig. 10), while the other wire is soldered to the spun-brass screw-thread which surrounds the cylindrical part at the top of the lamp, and when the lamp is screwed into the socket (Fig. 11) the circuit is completed or broken by the switch or key already described.

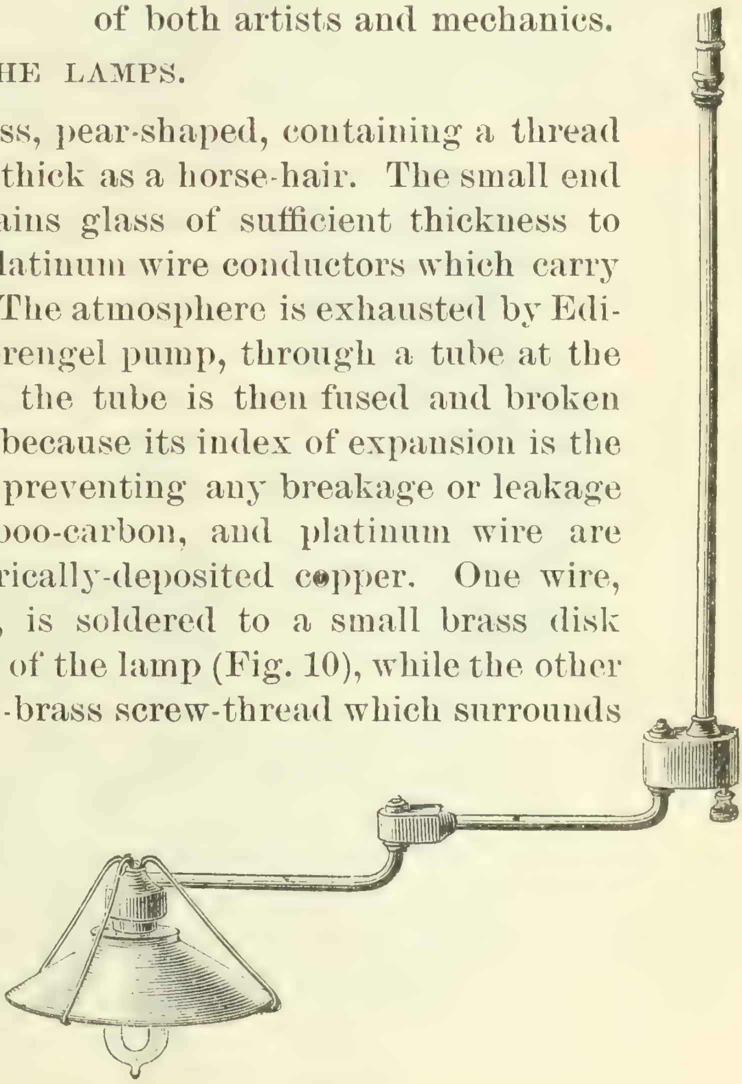


FIG. 7.

When the circuit is closed the carbon thread becomes heated to incandescence—from its high resistance—and continues to glow, in vacuum, without burning, so long as the cur-

rent continues to flow. Fig. 12 shows a lamp screwed into its socket.

By varying the length, and also the sectional area of the carbon

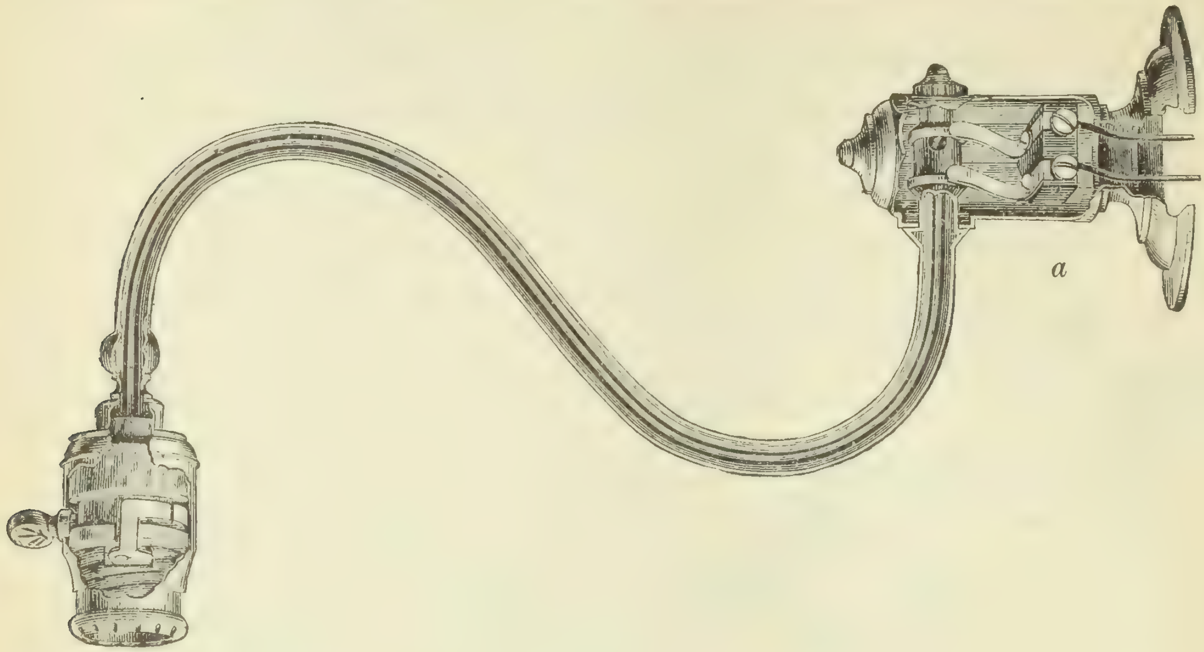


FIG. 8.

thread, keeping the electro-motive force constant, Edison has varied the candle-power of his lamps. In our circuit we have a few 16 candle-power lamps, though most of them are of 8 candle-power only. The cop-

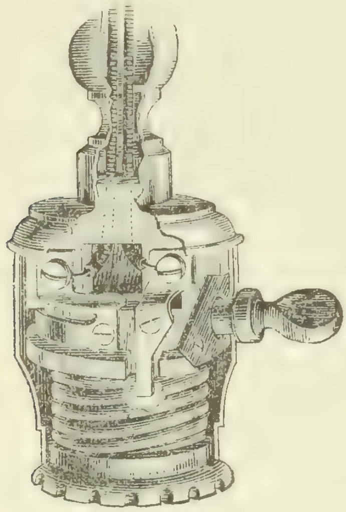


FIG. 9.

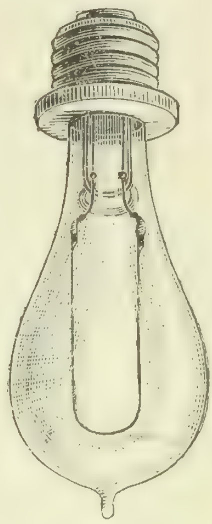


FIG. 10.

per wires, being of high conductivity, and of ample size, carry the current with but little warming, notwithstanding the white heat of the carbons in the circuit; by varying the size of the wires it will be found they follow the same law as to resistance and heating as the carbons.

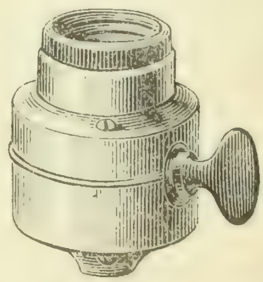


FIG. 11.

Let R = the resistance of a conductor; S = its sectional area; L = its length; a = a constant depending on material of which the conductor is made; then S R = a L, and from this simple equation the relative sizes of the wires and carbons have been determined.

The "life-time" of these lamps is warranted to be 600 burning hours, and their cost is 85 cents apiece.

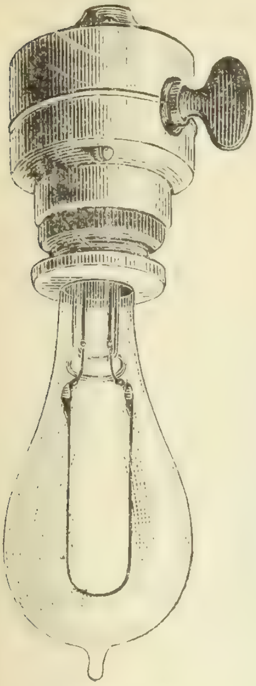


Fig. 12.

SAFETY CATCHES.

In event of a "short circuit" (an accidental connecting of the + and — wires) by a good conductor there would instantly be generated sufficient heat in the wires to melt them and to set fire to the adjacent woodwork, and possibly melt the armature also. To prevent this, Mr. Edison has devised his cut-out blocks and safety plugs shown in Figs. 13 and 14. The wires of the circuit connect to the binding screws in the blocks, while the plugs screw into the sockets of the blocks when the circuit is completed through the plugs, after the manner of the lamps; but the wire which connects the two poles of the plug is made of a fusible alloy, which melts at about 400 degrees, and the melting of this wire breaks the circuit. When this happens all the lamps fed through that plug will go out. These safety catches are placed on the main wires near the dynamo and on every branch circuit near the point where the mains are tapped.

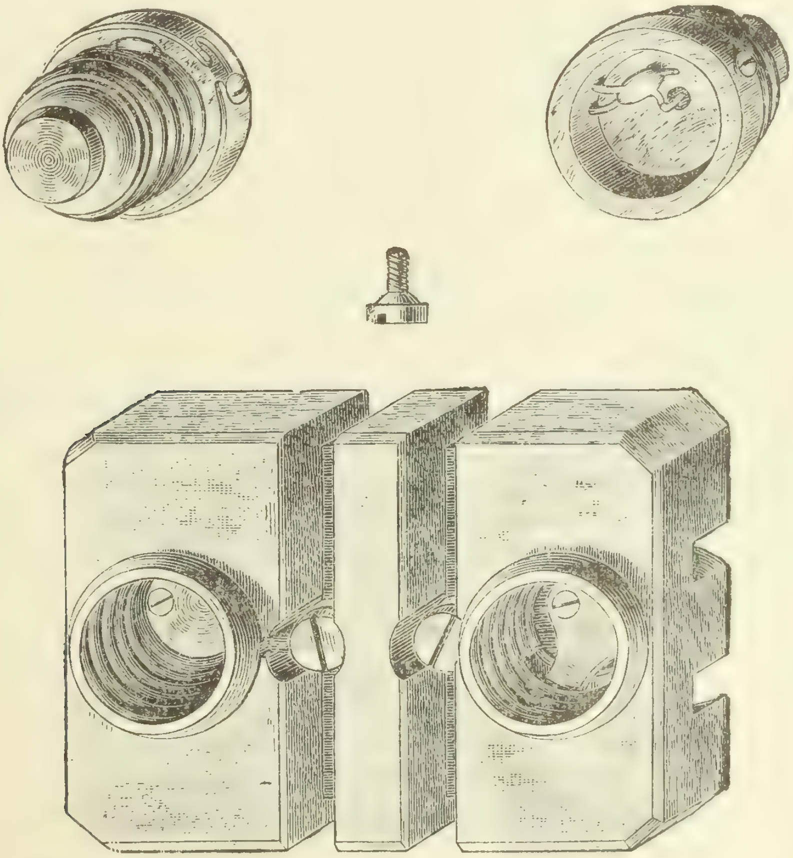


Fig. 13.

ECONOMY OF THE SYSTEM.

The writer indicated the engine with the current switched off; again with forty-five, with fifty, and finally with seventy lamps (8 candle-

power B lamps) in circuit, respectively. By deducting from these experiments, respectively, the power required to run the engine and dynamo we obtain the power applied to the shaft, and from this quan-

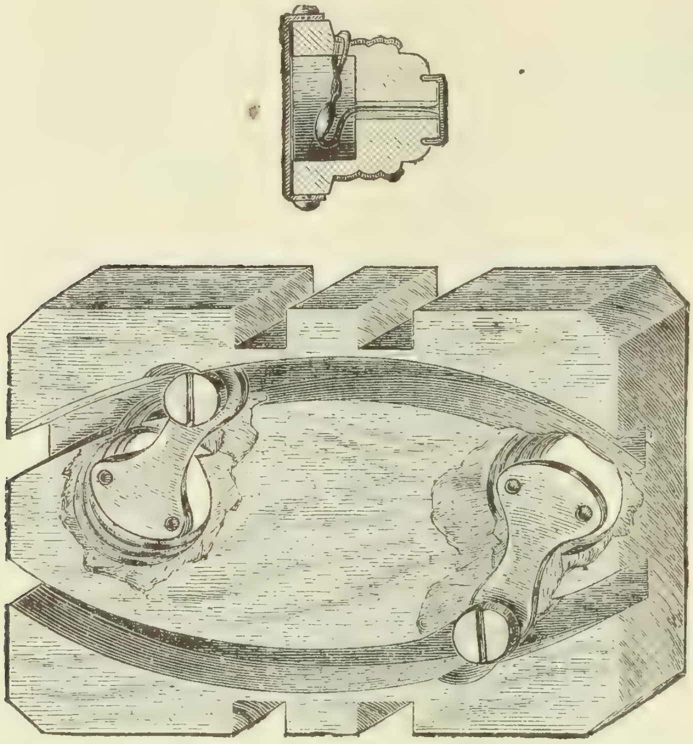


FIG. 14.

tity we deduct the friction of the load, leaving as a remainder the net power required to revolve the armature in the magnetic field with those respective lamps in circuit.

DISTRIBUTION OF THE POWER.

Horses-power required to run the engine and dynamo	3.56
Indicated horses-power required to run 45 lamps	5.79
Indicated horses-power required to run 50 lamps	5.85
Indicated horses-power required to run 70 lamps	6.92
Net horses-power applied to the revolution of the armature in the magnetic field, using 45 lamps	1.80
Net horses-power applied to the revolution of the armature in the magnetic field, using 50 lamps	1.85
Net horses-power applied to the revolution of the armature in the magnetic field, using 70 lamps	2.84
Mean number of lamps, per indicated horse-power, using 45 lamps	7.77
Mean number of lamps, per indicated horse-power, using 50 lamps	8.50
Mean number of lamps, per indicated horse-power, using 70 lamps	10.11
Mean number of lamps, per net horse-power, using 45 lamps	25.00
Mean number of lamps, per net horse-power, using 50 lamps	27.02
Mean number of lamps, per net horse-power, using 70 lamps	24.63
Mean of the last three quantities	25.55

So far the greatest number of lamps in operation at any one time has been (to the best of the writer's knowledge) 70, and he believes the average number to be about 47. The number of lamps, per indicated

horse-power, increases with the number of lamps used, for the reason that the fraction of the power utilized becomes larger at the higher power. The cost, in coal, of a horse-power developed by the dynamo-engine has been arrived at by calculating the quantity of steam passed through the steam-cylinder and reducing this to pounds of water evaporated by a pound of coal. Had steam been used for the light alone this calculation would have been unnecessary, but as it was used from the same boiler to warm, ventilate, and light the ship at the same time, the writer adopted this method of separating the respective quantities. From these indicator diagrams I have calculated that a horse-power costs 30.7 pounds of water or 3.41 pounds of coal per hour. The mean cost of coal during the two* years the ship has been in commission has been $6.07 per ton, or 0.271 cent per pound. The total cost of the oil used on the dynamo and its engine has been $106.74.

During the year 1833 the dynamo was in operation 1,592 hours and 45 minutes, and during 1884 1,481 hours and 30 minutes, making a total of 3,074 hours and 15 minutes.

The cost of running the plant for the two years has been—

Total cost of coal:	
For 1883	$79.60
For 1884	95.51
Total cost of oil:	
For 1883	48.57
For 1884	58.17
2 K brushes	5.00
11 Z brushes	11.00
2 cut-out blocks	.64
73 3-light cut-out plugs	5.84
16 6-light cut-out plugs	.48
5 20-light cut-out plugs	.40
13 40-light cut-out plugs	3.20
5 key-sockets	4.60
2 pounds of insulation compound	.24
1 wire shade-holder	.10
½ pound insulation tape	.24
2 attachment plugs	.80
3 pounds No. 14 insulated wire	1.20
1 pound No. 20 insulated wire	.40
1 new valve for the engine	5.00
1 new cross-head for the engine	25.00
1 new belt	20.00
Repairs (shortening) of belts	5.62
241 lamps†	241.00
Total expenditure, exclusive of labor and interest	665.97

*These figures include the work for 1883 and 1884.

†The lamps do not now come in the writer's department on board, but are here entered to complete the account.

As the engine and dynamo are run by a coal-heaver in addition to other duties, the writer has not entered the item of wages.

As the price of the lamps has been reduced 15 per cent, and the price of fixtures continues to diminish, we have no doubt that the running expense of the light will grow less. During 1884 we paid as high as $18 a ton for coal, at Aspinwall, and in 1883 as low as $3.93 a ton, at the Norfolk navy-yard. Between such ranges the cost of the light must vary, but as the writer has included all the coal consumed on board for that purpose during the entire period of the ship's existence, he believes the mean will be found to be very close to the correct one.

A correct average number of lamps cannot be ascertained where they are being turned on and off by so many persons, but the writer's average, taken from a number of observations, places the number at 47½. Assuming this to be correct, the cost of the light in candles-power per hour becomes $\frac{66597}{(1592.75+1481.5)\ 47\frac{1}{2}\times 8} = .05707$ cent.

This is about 38 per cent more than the cost of an equivalent amount of gas-light in Washington City, where coal costs less than $5 per ton.

DEEP-SEA LAMPS.

Our deep-sea cable is 940 feet in length and is coiled upon a reel, from which it may paid out to any depth within that limit. The lamps are according to Edison's patent, but the wires simply extend through the bottom of the lamp, the ends being free. We solder these wires to our cable, insulate with gutta-percha, tape, and "insulation compound." The lamps are of about 42 ohms resistance and are about 16 candle-power. The lamps burn quite well under water and can be seen very plainly at moderate depths, but they disappear entirely when 70 feet below the surface. We have had the deep-sea lamp down about 750 feet. There are two other submarine lamps, having each about 40 feet of cable with attachment plugs, so that they can be attached to any lamp socket. These have been used by the naturalists, who immerse them a few feet beneath the surface of the water to attract marine animals; by this means they have secured squid in large numbers, amphipods, silver-sides, young bluefish, young lobsters, and flying-fish, and dolphins have been seen to approach these lamps.

WARMING AND VENTILATING.

Experiments made by the writer on two wooden ships of the Navy show that 1 square foot of steam "radiator" surface is sufficient to warm 1 cubic foot of space on shipboard, even in the coldest weather, and he employed that rule in proportioning the steam radiators for the Albatross. The simplest forms of radiators were adopted, and we find, in practice, that they are quite as "noiseless" as the patented radiators, when properly piped for draining. In the pilot-house we adopted a plain return-

bend brass coil; in the deck-house rooms we put single columns; in the cabin, ward-room, laboratories, captain's office, and chart-room, and berth-deck apartment we put common steam radiators having cast-iron rectangular bases with vertical 1-inch wrought-iron tubes, 35 inches high, screwed into the open bases. The 1-inch (inside diameter) tube, 35 inches long, gives, in round numbers, 1 square foot of surface, making the distribution of the surface quite simple. Among the advantages of steam heat on board ship are cleanliness, easy regulation, economy of space, and safety.

The water condensed from the steam in the radiators is trapped and conveyed into the "hot well" (whence it is pumped into the boilers) or into a tank which is used as a reservoir for washing water.

The ventilation is effected by a single Sturtevant exhaust fan, driven directly from a "Wise motor," shown in Fig. 15. The fan has openings

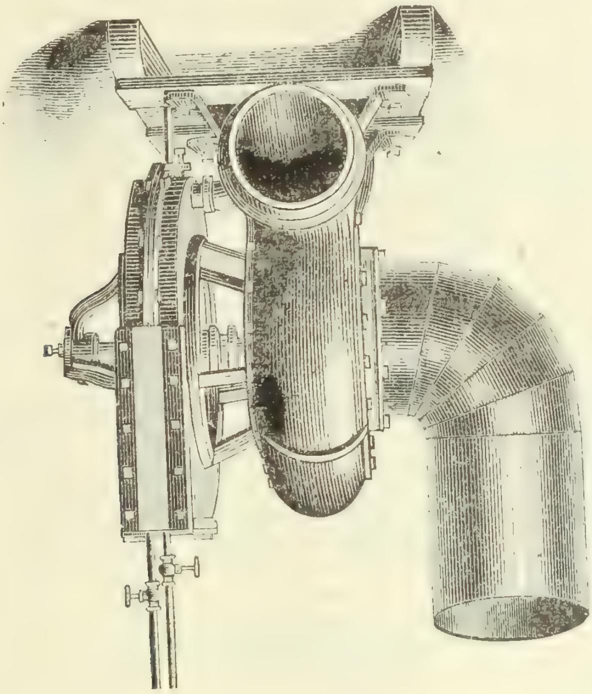


FIG. 15.

of 14 inches diameter, both for receiving and for discharging the air; there are two branch (11-inch) pipes from the suction side of the fan, one running to each side of the ship, and these 11-inch pipes branch into a 9-inch pipe leading forward and a 7-inch pipe leading aft, on each side of the ship. There is a sliding gate in each of the 9 and 7 inch conduits, near their connection with the 11-inch mains, which enables us to close either section; this would be essential in case of fire. The 9 and 7-inch conduits, which run close under the lodger plates of the berth deck, diminish in size to the extremities of the ship, where they are only 3 inches in diameter. From these pipes, or conduits, we have led 3-inch diameter pipes through the deck to the apartments to be ventilated, these small pipes terminating in polished brass registers, the area through which may be regulated at will. The conduits are made of Root's spiral galvanized wrought-iron pipe, the edges riveted

and soldered, and though none of it is over No. 16 in thickness, it is amply strong for the purpose. The polished registers are made to finish with the joiner-work of the ship, and the pipes connecting them with the conduits are, wherever possible, led behind the ceiling and other joiner-work, and are quite out of sight. The fan is too well known, commercially, to warrant a detailed description here; it is sufficient to say that it is a Sturtevant No. 6 centrifugal exhaust fan, and that the ventilation of the ship is effected by drawing out the foul air, permitting the fresh air to find its own way in, to supply the void, and is known as the aspiration system. The motor, though one of the earliest forms of steam-engine, bears a recent United States Patent Office date, and is remarkable alone for its simplicity. It consists essentially of a short hollow cylinder, its axis horizontal, containing a wheel in the circumference of which there is placed a number of pockets or "buckets." The "buckets" just clear the surface of the cylinder, and revolve freely within it; there are eight steam jets, arranged in such a manner that the steam from them will impinge directly into the buckets and cause the wheel to revolve upon its axis. The shaft of the motor extends through and is also the shaft of the fan. The fan, according to the figures of the builder, requires 2.86 horses-power to drive it 1,018 revolutions per minute, at which velocity it should deliver 3,669 cubic feet of air per minute. The quantity of air and the consequent size of fan was determined from the experiments of the writer, on board the United States ship Vandalia in 1879.*

Let Q=the number of cubic feet of air to be supplied; n=the number of men; a=the cubic feet of carbonic acid exhaled per man per hour (.0686); b=fraction of carbonic acid normal to the external atmosphere (.0004); c=fraction of carbonic acid found in the apartment. Then

$$na+Qb=(Q+na)\,c$$

from which we find

$$Q=\frac{na-nac}{c-b} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

From the experiments referred to we found the value of c to equal .0006983. By substituting numericals for letters and deducing we found 2,298 cubic feet per hour per man to be necessary.† The No. 6 fan, therefore, would be ample to ventilate for the 65 people who were to compose the crew, and leave us a reserve of nearly one-third its capacity for the hold of the ship, which we also provided with registers.

It at once became a matter of interest to know what quantity of steam was being used by the motor, and to ascertain, within reasonable

* Proceedings of the Naval Institute for 1880.

† The chemical analysis of the air were made by Dr. Arthur, of the Navy; the writer is responsible for the air measurements, the method, and the correctness of the calculation.

limits, what power was produced from this. For this purpose the writer connected the exhaust-pipe from the motor with the distilling apparatus, measured the condensed water by a "crown meter" and verified it by measurement in the ship's tanks, where the water was delivered.

Experiment to determine the power and the economy of the fan-motor.

Duration of the experiment, in hours	12.
Cubic feet of water condensed from the exhaust	96.75
P=Absolute steam pressure, mean, per square inch, in pounds	63.00
T=Temperature of the water	91°
Relative volume of the steam and water	409.
Volume of steam, in cubic feet	39,570.75
Cubic feet of steam per second	0.916
A=Area of the steam jets, in square feet	0.0027266
V=Velocity of the steam, in feet, per second $\left(\frac{.916}{.0027266}=\right)$	332.2
W_1=Weight of a cubic foot of steam at P pressure, in pounds	0.152445
w=Weight of steam per second	0.13808
R=Radius, to center of pressure of the "buckets" or vanes, in feet	1.2916
N=Number of revolutions per minute	550.
U=Velocity of the vanes ("buckets"), in feet, per second	74.3944
W=Work done.	

Then

$$W=\frac{w}{2g}(V^2-U^2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This assumes that the total velocity lost by the steam is utilized in power.

$$U=\frac{2\pi RN}{60}$$

and

$$w=VAW_1=.13808 \text{ pounds of steam per second.} \quad . \quad . \quad (3)$$

Substituting in equation (2) we have

$$\frac{.13808}{64}(332.2^2-74.3944^2)=.00216\,(110356.84-5533.87)$$

$=226.417$ pounds of work per second, or $\frac{226.417}{550}=0.41$ horse-power.

A cubic foot of water at T degrees weighs 62.07 pounds; the volume of water condensed per hour was $\left(\frac{96.75}{12}=\right)$ 8.0625 cubic feet. Consequently, the weight of water per horse-power per hour was

$$\left(\frac{8.0625\times 62.07}{0.41}=\right) 1220.6 \text{ pounds.}$$

During the entire experiment the two throttles on the motor were kept wide open.

Though the fan does not run as fast as expected, the air is changed

rapidly in the ship, and there is an absence of odors peculiar to ships, of the "stuffiness" in the sleeping apartments, and of the sensation of headache and nausea on waking in the morning.

STEAM CUTTERS.

The Albatross is provided with two steam cutters, built by the Herreshoff Manufacturing Company, of Bristol, R. I., from their own designs. The boats have wooden hulls, the larger one being coppered; both are fastened with screws, and are built as light as is consistent with strength. They have compound engines, Herreshoff's patent coil boilers, and external surface condensers. That which distinguishes Herreshoff's system is the coil boiler fed at the top, emptying its steam and water into a separator (whence steam is fed to the engine), and a "circulating pump" which takes the excess of feed-water from the bottom of the separator and delivers it again to the top of the coil. The larger boat has its shaft parallel with the base line and has a 4-bladed screw; the smaller boat has its shaft inclined, passing through the bottom of the hull, a little to one side, and about amidships, and has a 2-bladed screw; just outside the hull there is a universal joint in the line shaft, which permits the screw being pulled close up under the bottom of the hull, with its two blades lying horizontally, in a recess left in the keel, and when thus placed the lower edge of the keel is below the edges of the screw. The object of this is to protect the screw when passing over shoals. The screw being placed under the bottom of the hull, works always in solid water, and no matter how rough the sea, the propeller is never thrown out of water, and does not "race." Fig. 16 is a cut of the double-coil boiler of the steam cutter. The feed water enters the bottom of the outer coil, passing upward and through the spiral coil, then into and down the inner coil, and finally up, through an external pipe F, and into the separator D. The gases of combustion pass through the spaces between the coils. The furnace is lined with fire-bricks to a height of about 6 inches, and the coils are supported by wrought iron straps, with stirrup bolts, resting on the fire-bricks; the casing of the boiler is of sheet iron. The lightness of the boiler, the very small amount of water it contains, its great strength, and large heating surface give it great advantages over other boilers, and its results have been admirable. The boiler of the smaller boat is similar to the one in Fig. 16, except it has not the outer coil.

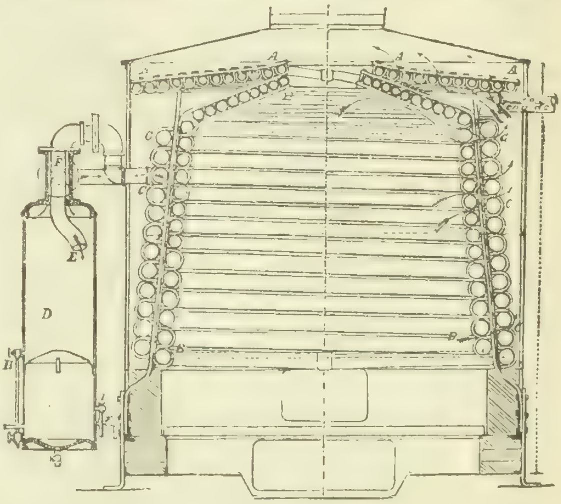


FIG. 16.

Fig. 17 is a perspective view of the engine of the cutter.

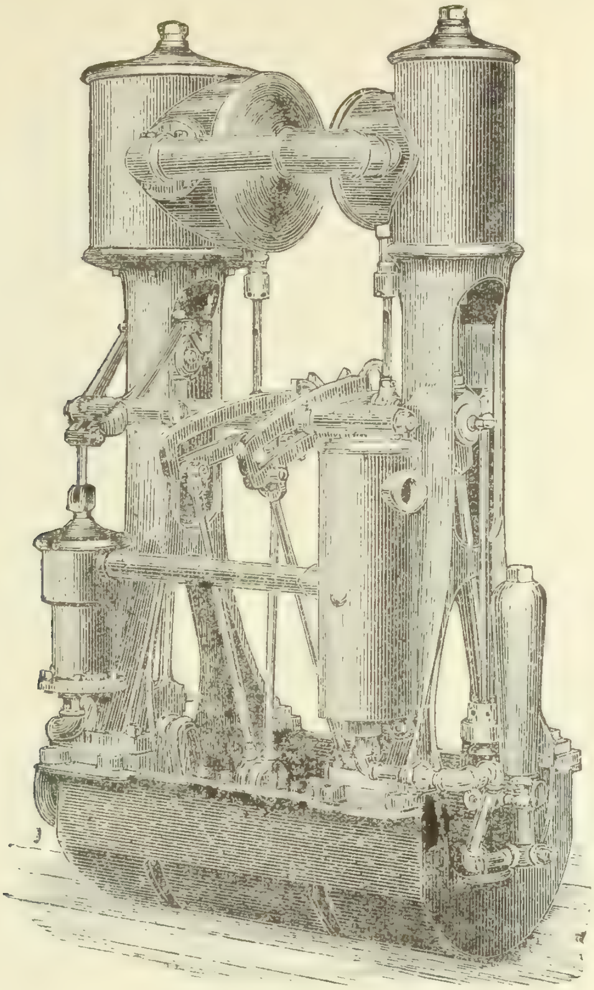


FIG. 17.

The principal dimensions of the boats and machinery are as follow:

	Large boat.	Small boat.
Length from forward edge of stem to after edge of stern..................feet..	26.500	25.083
Length at the load water-line..do....	24.500	24.583
Greatest beam..do....	6.750	5
Beam at the load water-line..do....	6.400	4.833
Depth from top edge of gunwale to lower edge of rabbet of keel:		
Forward..do....	4.333	3.500
Amidships..do....	3.417	2.667
Aft..do....	3.677	3.667
Draught of water, exclusive of keel:		
Forward..do....	1.667	1.417
Amidships..do....	1.625	1.417
Aft..do....	1.583	1.417
Depth of keel:		
Forward..do....	.25	.208
Amidships..do....	.625	.458
Aft..do....	1.000	.375
Area of greatest immersed transverse section..................square feet..	7.27	6.216
Area of load water-line..do....	101.65	86.67
Aggregate area of the wetted surfaces................................do....	116.25	99.76
Displacement at the load water-line...........................cubic feet..	89.29	46.86
Weight of hull and fittings...................................pounds..	3,300	1,700
Weight of boiler...do....	1,115	527
Weight of coal and water...do....	780	690
Weight of engine, including screw....................................do....	520	182
Weight of the boat complete..do....	5,715	3,099
Number of boilers..	1	1
Diameter of casing of boiler.......................................inches..	36	26
Extreme height of boiler from ash-pit to base of smoke-pipe..........do....	39	32

	Large boat.	Small boat.
Diameter of furnace ....inches..	29	22
Area of grate surface ....square feet..	4.58	2.64
Diameter of smoke-pipe ....inches..	10	8
Height of smoke-pipe above grate bars ....feet..	8.75	6.75
Diameter of separator ....inches..	6	3
Height of separator ....do....	31	26
Steam cylinders ....number..	2	2
Diameter of high-pressure cylinder ....inches..	$3\frac{1}{2}$	$2\frac{1}{2}$
Diameter of low-pressure cylinder ....do....	6	$4\frac{1}{4}$
Stroke of pistons ....do....	7	5
Diameter of the piston rods ....do....	$\frac{5}{8}$	$\frac{7}{16}$
Diameter of the air pump (single-acting) ....do....	$2\frac{1}{2}$	$2\frac{3}{4}$
Stroke of air pump ....do....	$2\frac{3}{8}$	$2\frac{1}{8}$
Diameter of circulating pump-plunger ....do....	$\frac{7}{16}$	$\frac{3}{8}$
Diameter of feed pump-plunger ....do....	$\frac{7}{16}$	$\frac{3}{8}$
Stroke of pumps ....do....	7	5
Length of condensing pipes ....feet..	15	$13\frac{1}{12}$
Condensing surface ....square feet..	9.83	4.95
Main journals ....number..	3	3.
Diameter of main journals ....inches..	$1\frac{1}{2}$	$1\frac{3}{4}$ and $2\frac{1}{4}$
Length of main journals ....do....	3	$2\frac{1}{8}$
Crank-pin journals ....number..	2	2
Diameter of crank-pin journals:		
High-pressure ....inches..	$1\frac{1}{2}$	$1\frac{1}{8}$
Low-pressure ....do....	$\frac{7}{8}$	$\frac{9}{16}$
Length of crank-pin journals:		
High-pressure ....do....	$1\frac{1}{2}$	1
Low-pressure ....do....	$1\frac{3}{4}$	$1\frac{1}{4}$
Space occupied by the engine:		
Length fore and aft ....do....	$24\frac{1}{2}$	21
Width ....do....	21	18
Height ....do....	44	26
Diameter of the screw propeller ....do....	28	$16\frac{1}{2}$
Pitch of the screw propeller (uniform) ....do....	48.72	30
Projected length of the screw on line of its axis ....do....	5	3
Blades of the screw ....number..	4	2
Friction of the pitch used	0.49	0.2
Helicoidal area of the screw blades ....square feet..	3.69	$\frac{1}{2}$
Weight of the screw ....pounds..	45	6

DREDGING ENGINE.

Plates XXIII and XXIV represent the dredging engine, the principal use of which is to hoist the trawls and dredges, but it is provided with additional "gypsy heads" for hoisting boats, &c. It was built by Copeland & Bacon, of New York, according to their patents. It has three gypsy heads (the large one of steel) mounted on the same horizontal shaft, and driven by a double-cylinder half-trunk steam-engine through the intervention of toothed gearing and a modification of Mason's friction clutch. The engines have locomotive valves which are actuated by Stephenson's links and eccentrics; the cranks are cast-iron disks; each pair of eccentrics is cast in one; the cut-off is effected by the lap on the valves. The machine has a friction brake to regulate the "paying out" of the dredge rope, and also a roller guide, with treadle motion, to press the rope aside and prevent the turns from riding. The engine is placed on the main deck, forward of the foremast; it takes its steam from the main boilers and may be exhausted either into the main condenser or into the atmosphere.

Its principal dimensions are as follow:

Greatest diameter of the large gypsy head ....inches..	$36\frac{1}{2}$
Least diameter of the large gypsy head ....do....	$22\frac{15}{16}$
Length of the large gypsy head on line of its axis ....do....	24
Diameter of the inboard end of the small gypsy heads ....do....	$21\frac{1}{2}$

Diameter of the outboard end of the small gypsy heads	inches..	11½
Diameter of the middle of the small gypsy heads	do....	8½
Length of the small gypsy heads on line of their axes	do....	12½
Total length over the three gypsy heads	do....	113½
Diameter of the main shaft	do....	4½
Diameter of the spur wheel at the pitch line	do....	40
Pitch of the teeth of the gearing	do....	$2\frac{1}{16}$
Width of the face of the gearing	do....	6
Width of the face of the friction brake	do....	4
Number of journals on the main shaft		2
Diameter of the journals on the main shaft	inches..	4
Length of the journals on the main shaft	do....	13
Diameter of the pinion on the pitch line	do....	9
Number of steam cylinders		2
Diameter of the steam cylinders	inches..	10½
Width of the piston trunks fore and aft	do....	9
Width of the piston trunks athwartship	do....	2¾
Area of cross-section of each trunk	square inches..	23½
Net area of the steam pistons, each	do....	74.84
Stroke of the pistons	inches..	10
Number of journals on the crank shaft		2
Diameter of the crank-shaft journals	inches..	3¼
Length of the crank-shaft journals	do....	6
Diameter of the crank pins	do....	1¾
Length of the crank pins	do....	2
Length of the engine base fore and aft	do....	60
Width of the engine base athwartship	do....	96
Height of the engine	do....	53½
Weight of the engine	pounds..	6,500

POWER OF THE DREDGING ENGINE.

The wire rope from the dredge passes over the dredging block at the end of the dredging boom, then under a sheave in the heel of the boom, then upward and over a block suspended from the "accumulator," and then to the central (or large) gypsy head of the dredging engine.

The "accumulator" (Plate XLIV), which is a series of rubber "buffers" moving freely on their longitudinal axes by the tension on the dredge rope, becomes a good dynamometer, though its motion is small and its scale fine. By taking a large number of dynamometer readings simultaneously with indicator diagrams from the dredging engines, noting at the same time the actual velocity of the rope as it is measured by the register on the boom sheave and also the speed of the engines, and by taking the mean of these quantities we shall approach very closely to the true conditions.

The gypsy head, by which the wire rope is wound, is curved, and the rope comes in, consequently, on a varying diameter; as the mean velocity of the wire is less than that due to velocity of the center line of the wire wrapped on the smallest diameter of the head it is evident there is a slip. The tendency of the rope, winding on the head, is to coil into a helix, but the inclination of the surface causes the wire to surge

toward the central part of the head, with some jar, slipping back at the same time. The loss of power due to this slip, plus the power required to overcome the stiffness of the rope in bending it on the head, will be found by taking the difference between the net power applied to the revolution of the gypsy head and the power indicated by the dynamometer.

The diameter of the smallest part of the gypsy head is $22\frac{15}{16}$ inches, and the diameter of the wire rope is three-eighth of an inch, consequently the velocity of the rope, per revolution of the head, supposing there were no slip nor "creeping", should be $\pi\left(\frac{22\frac{15}{16}+\frac{3}{8}}{12}\right)=6.104$ feet,* but from the reading of the register it is only 5. 924 feet.

The following record is from the mean of a number of observations made by the writer and assistants:

Velocity of the rope indicated by the register, in feet, per minute	148.600
Velocity of the rope due to the smallest diameter of the gypsy head	153.100
Tension on the wire, in pounds, indicated by the dynamometer	2,737.5
Revolutions of the gypsy head per minute	25.083
Revolutions of the engine per minute	107.500
Indicated horses-power developed by the engine	15.563
Indicated horses-power required to work the engine	1.453
Horses-power absorbed by the friction of the load	1.167
Net horses-power applied to the tension on the rope	12.943
Horses-power accounted for by the dynamometer	12.327
Horses-power absorbed by the slipping and bending of the rope on the gypsy head	.616

The 15.563 horses-power indicated by the engine is divided as follows:

	Per cent.
For pulling in the rope	79.207
For working the engines	9.335
For overcoming the friction of the load	7.500
For overcoming the slip and bending of the rope	3.958
	100.000

REELING ENGINE.

The reeling engine, Plate XXV, was built by Copeland & Bacon, of New York, and is of the same character of design as the dredging engine. Its object is to stow the wire rope, and to keep a limited tension on that rope when in motion. It is essentially a wrought-iron, built-up drum, mounted on a horizontal axis, driven by a double-cylinder half-trunk steam-engine, through the intervention of toothed gearing and a friction clutch. It has a friction brake to regulate the paying out.

It is provided with a traveling guide, mounted in front of the drum, for guiding the rope smoothly and uniformly upon the drum. The guide is actuated by a double screw, with equal right and left pitches,

*This is on the assumption that the rope travels on a radius due to that of the gypsy head plus its own radius, which has been proved by the passage of the same wire over our register sheave.

similar to that employed on the distributing roller of the Adams printing press; this screw reverses the direction of the guide when it reaches the end of the thread, and the pitch of that thread is equal to the diameter of the rope. It is geared to the drum by toothed gears of equal pitch diameters, one of which has a clutch coupling for disengaging. When paying out rope the guide is disengaged not only from the toothed gears, but also from the double screw, which leaves it free to travel by the pressure of the wire rope upon its sides.

The principal dimensions and the weight of the reeling engine and wire rope are as follow:

Diameter of the drum	inches	16
Length of the drum	do	36
Width of the flanges	do	17
Ratio of the gearing		$4\frac{2}{19}:1$
Number of steam cylinders		2
Diameter of the steam cylinders	inches	$7\frac{1}{2}$
Stroke of the pistons	do	8
Length of $\frac{3}{8}$-inch diameter wire rope the reel will hold	fathoms	4,500
Weight of the reeling engine	pounds	3,500
Weight of the 4,500 fathoms of wire rope	do	5,940
Total weight of the engine and wire rope	do	9,440

The engine receives steam from the main boilers and exhausts it into the main condenser or into the atmosphere as desired.

The wire rope, after leaving the dredging engine, is passed under a governor, *a* (Plate XXV), then to a leading block forward of the engine, and finally back to the reeling engine. The object of the governor is to keep a tolerably uniform tension on the rope, compensating for the surging on the dredging engine, and at the same time accommodating the plane of its sheaves' rotation to the varying direction of the wire rope as it passes. This governor is the invention of Lieutenant-Commander Tanner, the writer being responsible for its proportions. It consists of a sheave revolving in a vertical plane, within a frame which moves on a horizontal axis; the pressure on the sheave being resisted by a spiral spring shown in Plate XXV. To augment the efficiency of the governor the writer added the bell-crank and rod (*b*) to operate a Watson & McDaniel pressure-regulating valve, instead of the throttle as was originally intended. By this simple arrangement the tension on the wire between the dredging engine and the reeling engine controls the motion of the latter. The pressure regulator is automatic, independently of the motion of the engine, and is, therefore, an additional safety; it is similar to the valve shown in Fig. 18, but has a lever and weight instead of a spring as shown in that figure.

SOUNDING ENGINE.

The sounding engine (Plate XXVII) was built by Copeland & Bacon, of New York, according to the design and safe patent of Mr. E. C. Bacon. It is a single-cylindered, vertical, half-trunk engine with a lo-

comotive slide valve, actuated by a rod and a pin in the end of the shaft. The cranks are cast-iron disks, one of which is scored to receive a round belt for driving the drum which carries the sounding wire.

The steam cylinder is $5\frac{1}{4}$ inches in diameter and the stroke of piston is 5 inches. The diameter of the driving wheel (or crank) measured to the center line of the round belt is 13 inches, and the diameter of the drum, measured in the same manner, is $24\frac{1}{8}$ inches. The power of the engine is ample and its design is simple. It exhausts into the main condenser, and the cylinder cocks have been piped to discharge into the exhaust passage.

The belt is unshipped when the sounding wire is being paid out, and must be shipped each time it is hove in, which occasions a little delay, but when this is finished and the cylinder clear of water, the engine hauls in the wire at the average rate of about 100 fathoms per minute. The speed of the engine is usually regulated to the tension on the wire as recorded by the dynamometer, the attendant keeping it as nearly as possible at 80 pounds, which is about 40 per cent of the maximum strength of the wire.

THE STEAM WINDLASS.

This machine, shown in elevation in Plate XIV, is commercially known as the "No. 4, Providence capstan windlass," and was built by the American Ship Windlass Company. It is situated under the forecastle on the main deck. The windlass portion consists of a horizontal wrought-iron shaft, mounted in journals on cast-iron frames, and carries two gypsy heads, *a a*, two cam-clutch wheels, *d d*, a bevel gear-wheel, and a spiral gear-wheel, which are keyed to the shaft; it also carries a pair of chain-holders, *b b*, and friction-breaks, *c c*, which are not keyed to the shaft. The bevel gear communicates motion to or from the capstan, and may be uncoupled by unkeying the pinion; the spiral gear is for communicating the motion of the engine to the windlass. By revolving the cam-wheels, *d d*, a fraction of a revolution they are coupled to the chain-holders, *b b*, by which means the chain-holders may be made to revolve with the shaft at pleasure, and by this means the chain may be veered to one anchor while the other is hoisted; both may be hoisted or both veered while the engine is in motion. The capstan is on the forecastle deck and is keyed to the shaft or spindle *f*. This capstan, which is revolved through the bevel gears, is used for catting and fishing the anchors, for hauling upon hawsers, hoisting boats, &c.

The engines are placed horizontally beneath the forecastle deck. They rotate in the same plane, are placed at an angle of 90°, and act upon the same crank-pin. They have locomotive slide valves actuated by "loose" eccentrics, by which means the engines are reversible. The cylinders and their respective cross-head guides are in one casting, while the outer cylinder heads only are movable. The cylinders are sufficiently large to hoist both anchors at ordinary depths of water,

with 10 or 12 pounds of steam per square inch of piston, and for this reason we placed a pressure-regulating valve (Fig. 18) in the steam-pipe; by tightenning or slacking the screw we can adjust the steam in the cylinder to any pressure inside the limit of the boiler pressure.

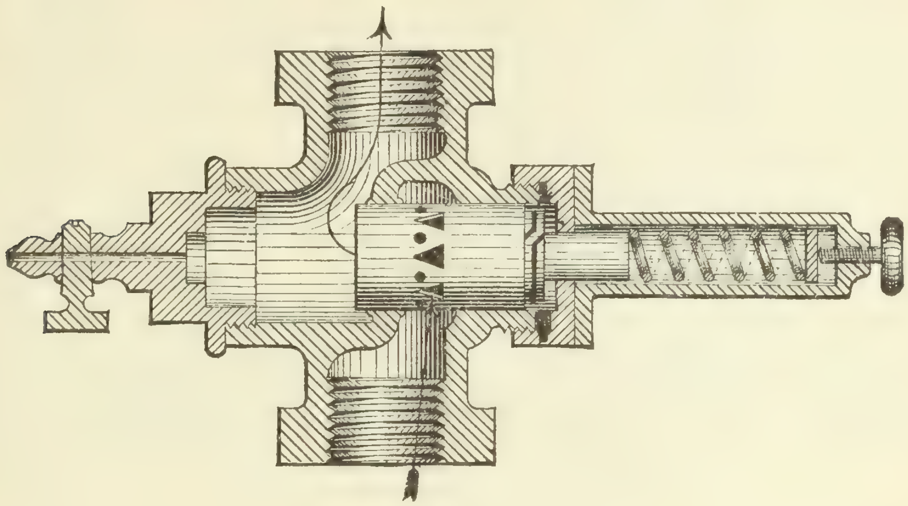


Fig. 18.

The engine takes its steam from the main boilers, and exhausts into the main condenser or into the atmosphere, as desired.

The principal dimensions of the steam windlass are as follow:

Diameter of the windlass shaft	inches	$3\frac{3}{4}$
Smallest diameter of the gipsy heads	do	$10\frac{1}{2}$
Largest (inboard) diameter of the gipsy heads	do	15
End (outboard) diameter of the gipsy heads	do	$13\frac{1}{2}$
Length of the gipsy heads	do	$13\frac{1}{2}$
Number of whelps on the chain-holders		5
Size of the starboard chain (diameter of iron)	inches	$1\frac{3}{8}$
Size of the port chain (diameter of iron)	do	$1\frac{3}{16}$
Chain per revolution of the starboard chain-holder	fathoms	$\frac{3}{8}$
Chain per revolution of the port chain-holder	do	$\frac{10}{17}$
Diameter of the friction-brakes	inches	23
Width of face of the friction-brakes	do	$2\frac{1}{2}$
Total length of the windlass shaft	do	92
Number of teeth in the bevel spur-wheel	do	49
Number of teeth in the bevel pinion		12
Number of teeth in the spiral gear-wheel		52
Number of convolutions of the "worm" screw thread		4
Outer diameter of the worm screw	inches	8
Radial length of the worm-screw threads	do	$1\frac{1}{4}$
Pitch of the spiral gear	do	$1\frac{5}{8}$
Diameter of the capstan spindle	do	$3\frac{7}{16}$
Smallest diameter over the capstan whelps	do	$10\frac{3}{4}$
Projected height of the capstan drum	do	14
Number of steam cylinders		2
Diameter of the steam cylinders	inches	8
Stroke of the pistons	do	8
Diameter of the piston rods	do	$1\frac{5}{8}$
Diameter of the connecting rods at the neck	do	$1\frac{1}{2}$
Diameter of the crank pin	do	$2\frac{3}{4}$
Length of the crank-pin journal	do	6

Diameter of the cross-head pins ......inches..	2
Length of the cross-head pin journals ......do....	2
Ordinary speed of the engine, in revolutions, per minute......	300
Rate of heaving in the starboard anchor, in fathoms, per minute	4
Rate of heaving in the port anchor, in fathoms, per minute......	$3\frac{4}{10}$
Length of the starboard chain......fathoms..	120
Length of the port chain......do....	120
Weight of the starboard chain ......pounds..	14,745
Weight of the port chain ......do....	9,283
Weight of the starboard anchor and stock......do....	2,760
Weight of the port anchor and stock ......do....	1,950
Total weight of both anchors and chains ......do....	28,737
Weight of the steam capstan windlass, complete......do....	9,000

The engine makes from 275 to 325 revolutions per minute; at 300 revolutions the velocity of the starboard chain would be 4 fathoms per minute and the port chain three and four tenths (3.4) fathoms per minute.

STEAM STEERING GEAR.

The steam steering gear, known as the "steam quartermaster," was built by the Pusey & Jones Company according to the patents and design of Mr. Andrew Higginson, of Liverpool, England. The machine may be shifted from steam to hand power by the motion of a clutch, and the same wheel is used for steering by steam as by hand. Like other improved steam steerers the valve is arranged to reverse the engine by changing the ports, and an automatic arrangement is provided to bring the valve to its middle position (and stop the engine) by gearing from the engine itself.

There are three half-trunk, oscillating, single-acting steam cylinders arranged at angles of 120 degrees from each other, all acting on the same crank pin, after the "brotherhood" system. The cylinders are $4\frac{1}{4}$ inches diameter and 5-inches stroke of piston. On the crank shaft is a toothed pinion which gears into a spur-wheel; on the shaft of the spur-wheel is keyed a second pinion-wheel which gears into a second spur-wheel, making the ratio of gearing nearly 36. The second pinion and the second spur-wheel are keyed to hollow cast-iron shafts, through which the other two shafts, respectively, work.

Motion is communicated to the tiller chains by a chain-holder (or "wild-cat") similar to those used on patent windlasses. On the extended portion of the upper shaft there is a screw thread on which a large nut works; this nut is clutched to one of the pinions; on the forward end of the same shaft is placed the steering wheel, 5 feet 4 inches in diameter.

The motion of the steering wheel communicates like motion to the clutch-nut, which, in turn, imparts motion to the slide-valve of the engines; and the motion of the engines, transmitted through the gearing described, revolves the clutch-nut upon its thread in the opposite direction, and brings the valve back to its central position. By this contri-

vance the engine ceases its motion directly the helmsman brings his wheel to rest. The slide-valve, is common to the three cylinders; it is circular in form, and revolves upon its center by gearing from the steering wheel; its partitions or ribs divide it into three valves (one for each cylinder), though it is one casting. The exhaust is delivered into the steam-tight box which incloses the engine, and all the oil the crank-pin and crank-shaft journals ever receive must come with the steam worked through the cylinders. It cannot be hoped to keep the engine-box and main journal-boxes tight against air-leaks, and when the steering engine is exhausted into our main condenser we find a diminution of vacuum. The mechanical performance of the machine is all that can be desired. The engine starts the moment the wheel is moved and stops with equal promptness; the power of the machine is ample and it is comparatively light and compact. The toothed gears are rather noisy when steam is used.

D.—APPARATUS FOR DEEP-SEA RESEARCH.

Sigsbee's machine for sounding with wire is shown in Plate XXVII as in position on board the Albatross.

Nomenclature of the machine and its appointments.

a. Cast-steel bed plate.
b. Oak bed plate.
c. Cast-steel frames for reel.
d. Steel reel.
e. Register.
ff. Guide frames.
g. Cap.
h. Accumulator-pulley.
i. Accumulator-rope attached to pulley.
j. Friction rope.
k. Hinged frame.
l. Cylinder of hoisting engine.
m. Driving pulley.
n. Ratchet crank.
o. Tightening-pulley.
p. Rope belt.
q. Belt tightener.
r. Flexible exhaust-hose.
s. Flexible steam-hose.
t. Strut.
u u. Castors.
v. Lewis bolt.
w. Brace.
xx. Guys.
y. Guide pulley.
z. Auxiliary brake.

The machine is placed on the port side of the topgallant forecastle, near the after end, and is rigged for reeling in.

The two bed plates *a* and *b* are firmly bolted together, the outboard end resting on a broad friction plate of brass (not shown in the sketch), one end of which is secured to the forecastle rail and the other supported by the strut *t*, which, by means of right and left hand screws on its ends, not only holds the friction plate in position, but regulates the height of the inboard end, so that the bed plate rests fairly on it at all times.

The friction plate has a groove along its center line through which passes a compressor bolt (not shown in the sketch), the upper end of which is secured to the bed plate, the lower end carrying a thread and nut. The inboard end of the machine is supported by a pair of brass castors, *u u*, arranged to conform to any direction in which it may be moved, and by simply tightening the compressor it is held in any desired position. For additional security when rigged out for use, a Lewis bolt, *v*, is set in the deck, through which a lashing may be passed to an eye-bolt on the bed plate.

The reel *d* is of steel strongly bolted; the sides are of boiler plate; the barrel is forged and welded; the hub is of cast iron, and the shaft of steel. The diameter of the reel is 22.89 inches, a turn of the wire equaling exactly one fathom, and it will hold about 6,000 fathoms of No. 11 music, 0.028 inch in diameter, the wire used in deep-sea sounding.

The friction ring, with the V-groove common to all sounding reels, is bolted to the right flange. The shaft carries a ratchet wheel on the left of the reel and a worm wheel on the right, into which the register *e* is geared.

The guide frames *f f* are hollow steel tubes, their bases screwed into the cast-steel hinged frame *k*, and their tops tied together by a steel casting which carries two pulleys, over which runs the accumulator-rope *i*. A neat copper cap *g* covers the apertures in the guide frames and protects the spiral accumulator springs inclosed within them.

The accumulator-pulley *h* is of brass, with brass guards over the upper half to prevent the wire from flying out of the score.

The frame is cast steel, having cross-heads working on guides bolted to the inner sides of the frames, with small grooved rollers at either end, the upper one for the accumulator-rope *i* and the other for the friction line *j*, the whole being very light in order to reduce its inertia to the minimum.

The spiral accumulator springs referred to above are 28½ inches long and 2½ inches outside diameter. They are made of No. 4 (American gauge) steel wire, and have an elastic limit of about 4 feet, with a weight of 150 pounds applied to the end of the wire, which will give the latter a cushioning of about 8 feet before it can be subjected to a violent jerking strain.

Graduated scales are so placed on the guide frames that the accumu-

lator springs act also as a dynamometer, showing at all times the strain on the wire.

The reeling engine *l* has its frame, which is of cast iron, in one piece bolted to the bed plate *a*. The cylinder is vertical (Copeland & Bacon's patent trunk) and 5½ inches in diameter.

The driving pulley *m* has a V-groove corresponding to that on the reel over which the rope belt *p* is rove. The tightening-pulley *o* actuated by the belt tightener *q* gives the belt the desired tension.

The ratchet crank *n* is used in working water out of the cylinder and also, in starting, to assist the crank over the center.

Steam is received through the flexible hose connection *s*, and the exhaust is carried through a similar one *r*, both having brass connections flush with the forecastle deck.

The guide frames are held rigidly in position by the guys *x x* and the brace *w*. The guide pulley *y* is shown in position, and the grating hinged to the side for convenience in handling sinkers, &c., is shown in the sketch.

The machine being rigged and in place, to take a sounding, reeve the stray line over the accumulator-pulley and down through the fair-leader, bend on the sounding rod with sinker attached, reeve the friction line *j*, as shown in the sketch, bringing the standing part up over the V-groove on the reel and making it fast to its hook on the bed plate between the reel and the engine; the hauling part being led out under and abaft the reel where it is attended by the officer in charge or a careful man. The belt is, of course, thrown off when sounding. Everything being in readiness, the sinker is carefully lowered to the water's edge, either by means of the crank or friction line (the former being preferable), the small lead is bent to the stray line, the thermometer and water specimen cup are clamped on, the register is set at zero, and the vessel laid properly. The officer in charge takes his station on the grating outside of the machine, where he has a view of the wire at all times. A seaman is at the friction line; another, crank in hand, stands on the left; another at the brake *z*, on the right, also with a crank, and a fourth is on the grating outside to attend the guide pulley, handle sinkers, &c. A fireman is stationed at the engine. The record keeper takes a favorable position for reading the register, and the officer in charge gives the order, "Let go!" The friction line is then given a tension that allows the sinker to descend from 70 to 110 fathoms per minute, as may be considered prudent, the record keeper timing each 100 fathoms.

The officer in charge maneuvers the vessel to keep the wire vertical. The instant the sinker strikes bottom the reel is stopped by the friction line, assisted, if necessary, by the brake. The record keeper notes the number of turns indicated by the register, the cranks are shipped and sufficient wire hove in by hand to clear the bottom, when they are unshipped and laid one side; the belt is adjusted, steam admitted to the

cylinder, and the ratchet crank brought into requisition to assist in starting with a gentle motion. As soon as the engine works uniformly the speed is increased and the wire hove in at the rate of 100 to 150 fathoms per minute, each 100 fathoms being timed by the record keeper the same as when going out. The last 10 fathoms are reeled in by hand. The thermometer is read by the officer in charge and verified by the record keeper; the specimen cup of water is turned over to the medical officer, who either determines the specific gravity of the water or preserves it in specially prepared bottles to be sent to the laboratory at Washington for chemical analysis.

To secure the machine when not required for use, remove the register *e*, belt tightener *q*, ratchet crank *n*, and the steam and exhaust hose *s* and *r*, and stow them away. Unship the reel *d* and stow it in its tank, which contains sufficient sperm oil to cover the wire. Cast off the lashing *v*, loosen the compressor, and run the machine in; slacken the brace *w* and guys *x x*, and bring the head of the guide frames *f f* inboard until they are horizontal, when the after one will rest in a crutch on the engine frame. The frame *k* will then be in a vertical position, the guide pulley will be lowered between the guide frames *f f*, the accumutator pulley *h* unshipped, and the upper half of the guide frames turned back upon the lower portion, a double-hinged joint being provided for the purpose. The machine will then be turned fore and aft on the friction plate close to the forecastle rail, where it is held in position by the compressor. A painted canvas cover is drawn over all and secured under the bed plate to protect it from the weather.

The clamp is a cylindrical piece of lignum-vitæ about 6 inches in length by 4 in diameter, divided longitudinally through its center, and right and left hand screws introduced, by means of which the halves can be separated or brought together. It is used for holding the sounding wire, when, from any cause, it is necessary to slacken it between the reel and guide pulley. It is usually carried in an appropriate socket on the bed plate, ready for instant use.

Defective splices are usually discovered while reeling in, and the clamp is brought into requisition to hold the wire while a new splice is made. The machine had some defects when received from the maker, D. Ballauf, Washington, D. C., although the workmanship was performed in the best possible manner. The Sigsbee reel, weighing about 90 pounds, proved unequal to the crushing strain to which it was subjected in depths exceeding 2,000 fathoms. We then strengthened one, adding about 40 pounds in weight, which did good service in depths up to 3,000 fathoms, but finally collapsed. Two heavier reels, weighing 150 pounds each, were then constructed. Sigbee's general plan was followed, the extra material being placed where former reels had been deficient in strength. We have experienced no further trouble in that direction, and the increased weight is hardly noticed in practice.

The round leather belts furnished with the machine were useless, and

were replaced by round gutta-percha belts, which answered very well so long as kept away from the cylinder of the reeling engine. This, however, was difficult at times, and when they did accidentally touch it the gutta-percha would melt almost as quickly as tallow The belt finally adopted is a simple grommet strap of 18 or 21 thread ratlin stuff which is quickly made on board ship, does its work well, and is very durable.

BELT TIGHTENER.

The tightening pulley was formerly adjusted by hand, requiring the united strength of two or three men; even then the belt would frequently slip. To remedy this evil the belt tightener (Plate XXVIII) was designed. I made a rough sketch of it, and Passed Assistant Engineer G. W. Baird, U. S. N., reduced it to the proper proportions, and superintended its construction. Fig. 1 shows a general view of the apparatus ready to be attached to the vertical shaft carrying the tightening pulley. This is done by placing it over the end and inserting the pin, Fig. 2, in a hole in the shaft, as shown in Plate XXVIII. By the use of this simple appliance the belt was promptly brought to the desired tension and our troubles in that direction ceased.

THE RATCHET CRANK (PLATE XXVIII).

The reeling engine having a single cylinder, it was found necessary in starting to open the throttle wide, and assist the crank over the center by hand, when it would start off at great speed, bringing undue strain on the wire. This difficulty was partially remedied by shipping the reel cranks and starting by hand, thus attaining the gentle motion desired. The only objection to this arrangement was the difficulty inexperienced men had in unshipping the cranks while the engine was in motion. A rachet crank on one end of the crank shaft seemed to me the simplest and most direct remedy, as it would always be in position for instant use; and, instead of unshipping it when the engine was working, it would remain in place, hanging vertically as shown in Plate XXVII. I made a rough sketch, and gave it to Passed Assistant Engineer Baird, who reduced it to the proper proportions, made a working drawing, and superintended the making of the crank, which has performed its work admirably. Fig. 1 is a front, and Fig. 2 a side view of the ratchet crank.

TANNER'S SOUNDING MACHINE (PLATE XXIX).

This machine was designed for service on board the United States Fish Commission steamer Fish Hawk, where it was used in depths not exceeding 800 fathoms. It is used on board this vessel when working in 200 fathoms or less, and for navigational purposes (where it is very useful, being always in readiness for sounding).

It is mounted on the port rail forward of the fore-rigging.

NOMENCLATURE.

a. Spindle.
b b. Frame.
c. Arm.
d d. Reel.
e. Guide pulley.
f. Fair-leader.
g g. Cranks.
h. Register.
i. Pin.
j. Reel-tackle block.
k. Accumulator spring.
l l. Stray line.
m. Friction rope.
n n. Accumulator rope.
o. Eye for friction rope.
p. Socket.
q. Set screw.
r. Guide.
s. Lead.
t. Clamp.

The spindle is made of iron, turned, slightly tapering, and screwed firmly into the base of the frame *b b*. There is a brass bearing on the rail through which the spindle passes, the lower end resting in the socket *p*. The set screw *q* holds the machine in any desired position.

The frame above mentioned is of brass, cast in one piece, is bored to receive the reel shaft, and has appropriate lugs for the pawl and register. The reel *d d* is of cast brass, 22.89 inches in diameter, the initial turns of wire equaling 1 fathom, increasing as the score is filled, its capacity being about 2,000 fathoms.

The V friction groove, common to all sounding reels, is on the right flange, and is part of the same casting.

The cranks *g g*, by which the reel is turned, have conical friction surfaces, which are brought into contact with similar surfaces on the ends of the reel shaft by moving the right crank one-half a revolution ahead, the left one remaining clamped at *t*, or held firmly in the hand. The reverse motion releases the reel, allowing it to revolve freely without moving the cranks.

On the left side, between the frame and crank, is a worm wheel which operates the register. The ratchet and pawl are shown on the right, between the frame and crank.

The arm *c*, which supports the guide pulley *e*, is of iron, hinged between lugs on the frame, and held in position by the pin *i*. The small metal reel-tackle block *j*, projecting from the arm, is part of a tackle for suspending the reel when mounting or dismounting.

The guide pulley *e* is of brass, with a V groove, the upper portion being covered with a guard to prevent the wire from flying off. The pulley is hung on a frame, having a spindle extending into the metal casing above, the small arm *k* being confined to its upper end by a nut.

A spiral accumulator spring surrounds the spindle, and is compressed by the weight of the lead *s*, giving the guide pulley *e* a vertical play of about 3 inches. The fair-leader *f* swings freely in and out, but is rigid laterally, and guides the wire fairly into the score of the pulley. The aperture through which the wire passes is lined with highly tempered steel.

The standing part of the friction rope *m* hooks to the eye *o* in the frame, is carried around the reel in the V groove, and the free end is secured to the bight of the accumulator rope *n n* at *m*; one part being hooked to the small arm *k*, and the other made fast to the arm *c*, for the purpose of supporting the friction rope when it is slack and preventing its flying out of the V groove. The guide *r* leads the wire fairly on the reel. The machine revolves freely, its weight being sustained by the socket *p*. The set screw *q* holds it in position.

To take a sounding, the wire being on the reel and the latter mounted, haul the friction rope hand-taut before the lead is attached, and while the guide pulley is up in place. In this position it requires a strong man to move the reel, but the lead being bent and suspended, it compresses the accumulator spring, and drags the pulley down sufficiently to slack the friction rope and allow the reel to revolve with comparative freedom. The instant the lead strikes the bottom, however, or the weight is removed from any cause, the pulley flies up, putting a tension on the friction rope, which instantly checks the reel.

The friction rope being properly adjusted, reeve the stray line over the guide pulley and bend on the lead. Throw the pawl out of action, attend the friction rope, and lower the lead to the water; set the register at zero, and take the cast, governing the speed of descent by means of the friction rope, which is grasped by the right hand at *m*. As soon as the lead reaches bottom, bring the cranks into action by turning the right one a half turn ahead, read the register, unclamp the left crank at *t*, throw the pawl into action and heave in. When the lead is up, clamp the left crank at *t*, move the right one a half turn back, thus throwing them out of action, and the machine is ready for another cast.

If there is much sea running, it is necessary to use a light lead attached to the upper end of the stray line to prevent kinking the wire when slackened by the vessel's pitching.

To dismount the reel reeve the tackle *j* and take the weight off the reel; remove the nut on the left or after end of the reel shaft, grasp the ratchet wheel with both hands, and withdraw the shaft and right crank, leaving the left crank and worm wheel in position; swing the reel clear and lower it on deck, returning the shaft and crank to their place. If the frame is to remain on the rail, remove the register, withdraw the pin *i*, and bring the arm and guide pulley down to the frame *b b*, turn the machine inboard, and tighten the set screw to hold it in position.

To wholly dismount the machine for transportation or storage, remove

the reel, cranks, and register, disconnect the arm at *i*, and unscrew the spindle from the frame. The total weight is 135 pounds.

In sounding with wire it is absolutely necessary to keep it taut, slack wire always kinks, and a kink is followed by a break. It is also liable, when slackened, to fly off the reel.

If the ordinary sounding wire (No. 11 music, Washburn and Moen) is used, it is necessary to protect it by keeping the reel in oil when not in use; but with a view to having the machine ready for service at all times, we substitute No. 21 wire, and allow it to remain on the reel without other protection than an occasional oiling. It rusts as a matter of course, but we find by experience that it lasts from six to eight months.

It is hardly necessary to observe that this heavy wire is practicable in depths of a few hundred fathoms only.

The machine is protected from the weather by a painted canvas cover.

PIANO-FORTE WIRE FOR SOUNDING.

The piano wire used for sounding by the vessels of the United States Fish Commission is made by the Washburn & Moen Manufacturing Company, of Worcester, Mass., and is called by them No. 11 music. It is 0.028 of an inch in diameter, corresponding to No. 21 American and No. 22 Birmingham gauge. It is furnished by the manufacturers in sealed tin cans containing 50 pounds each, or about 3,850 fathoms in six coils 8½ inches in diameter, containing about 640 fathoms in two lengths.

The coils are double, wrapped with heavy paper, a liberal sprinkling of whiting being inclosed with the wire. It is practically indestructible as long as it remains in the sealed can, and if put in a dry place will keep well in the paper wrapping after it is removed from the can. We have never lost a fathom of American wire from rust in the coil. It is highly polished and resists rust remarkably well when in use. Its weight is 1.3 pounds per 100 fathoms in air and 1.13 pounds in sea water. Its tensile strength is quite uniform, the mean of several tests giving the breaking strain 207 pounds. The cost is $1.50 per pound.

We have also used English wire from Messrs. Webster & Horsfall, Birmingham, England, of the same size, No. 22 Birmingham gauge (0.028 inch diameter), corresponding to No. 21 American gauge or No. 11 music.

The tensile strength from the mean of several tests was 214 pounds, practically the same as the American wire. The cost is 75 cents per pound.

It possesses certain disadvantages, however, for use on board ship, which tend to counteract the advantages derived from its cheapness at first cost. It is received from the makers in 18-inch coils, made up of pieces from 100 to 400 fathoms in length, the coils weighing about 60

pounds each. They are wrapped in oiled paper, which is liable to be torn in handling, exposing the wire to the sea air, when it is soon ruined by rust. The losses from this cause prove at times quite serious. When this wire is used for sounding it is advisable to put the whole supply on reels of some sort and place them in oil at once, where it will remain free from rust until it is required for use.

This wire is less highly polished than the American and for this reason rusts more quickly, requiring greater care when in use.

METHODS OF SPLICING WIRE.

The following simple and effective method was formerly used with good results, and, although no longer followed, it is worthy of mention. Clean the ends of the wire thoroughly for two feet and lay them together with about eight turns; wind the ends and two intermediate points with a few turns of very fine annealed wire; cover them with solder and smooth the surface with knife and sand paper.

MAY'S SPLICE (PLATE XXX).

Lieut. Sidney H. May, U. S. N., had general charge of the sounding apparatus during our first year's work, and among many useful suggestions was the wire splice above mentioned, which was used with such excellent results that we finally adopted it in preference to all others.

The ends are filed to a long tapering point, and thoroughly cleaned for about a foot, then laid together with four turns and a seizing of very small annealed wire put on near each end (Fig. 2). The tapered ends, which have become annealed during the filing process, are wrapped closely around the standing parts, and the whole splice is covered with solder by running it back and forth through a groove in a piece of board, in which a small quantity of solder is kept in a fluid state by the application of a soldering iron. It is smoothed down with knife, file, and sand paper. Fig. 3 shows the splice partially covered with solder, and Fig. 4 the completed splice; the total length of which is from 6 to 7 inches.

The ends are quickly tapered by grasping the wire with nippers or a small hand-vise, and laying it on a plane hard-wood surface for filing.

SPIRIT LAMP FOR SOLDERING SPLICES OF SOUNDING WIRE (PLATE XXXI).

The soldering iron has been partially superseded by the spirit lamp for soldering sounding wire. A quantity of solder is placed in the cup over the flame, where it is soon melted. The wire having been prepared as directed, is drawn back and forth through the fused metal until a sufficient quantity adheres, when the splice is smoothed in the usual manner.

METHOD OF SPLICING WIRE TO STRAY LINE (PLATE XXX).

In sounding with wire it is necessary to have a flexible cord between the sinker and wire to take up any slack that may occur when the former strikes the bottom. This cord is known as stray line, Fig. 5; cod line is used for the purpose, and is attached to the wire in the following manner: The wire is stuck twice against the lay 5 inches from the end of the stray line, then passed with the lay from 4 to 6 inches, the end stuck twice against the lay, and served over with sail twine. The wire is then passed with the lay to the end of the line, the strands trimmed down and served over with twine, and a seizing is also put on over the wire first stuck against the lay. This makes a neat and secure splice, which passes readily over the accumulator pulley without danger of catching on the guards or fair-leader.

THE MEASURING REEL (PLATE XXXII).

The service reel being 22.89 inches in diameter, the initial layer of wire, 0.028 inch in diameter, equals one fathom to the turn, the next layer a trifle more and so on, until with a full reel the error would be about 10 inches to the turn; and as the register indicates the turns only, a correction must be applied to its reading. In order to determine the amount of error, the wire is measured as it is wound on the service reel by means of the measuring reel, which is made of cast iron, is 22.89 inches in diameter, and mounted in a cast-steel frame bolted to a heavy oak bed plate. On the reel shaft between the reel and frame is a worm wheel which actuates the register.

THE BLADE (PLATE XXXII).

The blade is used in connection with the measuring reel for transferring wire from the coil to the service reel. Fig. 1 is a longitudinal sectional elevation showing the method of construction. It is made of oak with the following exceptions: an iron screw and washer at the top of the spindle, which supports the reel; a galvanized iron washer, which is placed on the reel over the coil of wire to prevent slack turns from flying off; and a galvanized iron rim around the base of the reel to confine slack turns that might fall between it and the bed. Fig. 2 shows the reel ready for service.

TRANSFERRING AND MEASURING WIRE.

The service reel is mounted on the Sigsbee sounding machine, which is set at any desired angle with the deck; the hand cranks and register are shipped, and the reel carefully cleaned and oiled.

The measuring reel is placed directly in the rear of the sounding machine, and the blade in the rear of the reel and in line with both. The sealed tin can in which the wire is received is opened, a coil taken out,

removed from the paper, and placed on the blade; the wire stops are cut, the free end of the wire led out, and three turns taken around the measuring reel in such a manner that the register will count ahead during the transfer. The end is then taken to the service reel, and clinched through the hole provided for this purpose. The two men at the blade reel back the slack wire, the record keeper sets both registers at zero, and takes his station for reading the one on the measuring reel, the officer in charge watching that on the service reel. The cranks are manned and the transfer begins, the reel being turned at any desired speed. One of the men at the blade puts a slight tension on the wire by applying an old piece of canvas in his hand to the iron rim at the base of the reel.

The record keeper calls out "mark!" at every 50 fathoms registered by the measuring reel, the officer in charge reads the register on the service reel at the same instant, and this being recorded the difference between the two readings shows the error at that point. This process being carried on until the reel is filled, furnishes data from which a correction table is made, by which soundings can be corrected readily by inspection.

A correction table once made for a certain reel is always available for that reel, or any others of the same dimensions, provided the amount of wire on it is less than that for which the table was constructed.

Correction table.—Reel No. 1.

0	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000
										53
									49	102
								43	92	145
							38	81	130	183
						32	70	113	162	215
					27	59	97	140	189	242
				22	49	81	119	162	211	264
			16	38	65	97	135	178	227	280
		11	27	49	76	108	146	189	238	291
0	7	18	34	56	83	115	153	196	245	298

ILLUSTRATIVE EXAMPLES.

Number of turns on the reel		4,500
Turns registered in sounding		2,500
Turns remaining on reel		2,000
Corrections	fathoms..	189
Turns	do	2,500
Depth		2,689

The table given above illustrating our method of correcting soundings gives the error for every 500 fathoms; but that in actual use on board gives it for every 50 fathoms and at any intermediate point it can be ascertained by a simple interpolation. This table is the work of Lieut. Seaton Schroeder, U. S. N.

SIGSBEE'S DETACHER (PLATE XXXIII.)

[Used in connection with a modification of Captain Belknap's sounding cylinder No. 2.]

The first device for detaching the sinker and bringing up a specimen of the bottom in deep-sea sounding was the invention of Passed Midshipman John M. Brooke, U. S. N., about 1852–'53. It consisted of a small iron rod carrying a trigger at the upper end, and a small tube at the other extremity, in which several goose-quills were placed for bringing up bottom specimens. The sinkers were much like those of the present day, a shot with a hole through it.

To prepare for a sounding the line was bent to the trigger, the goose-quills were adjusted in the tube, the sounding rod was inserted in the hole through the sinker, the slings were passed under the sinker and hooked to the trigger, which sustained the weight until the sounding line was slackened by its striking the bottom, when the trigger capsized by its own weight, the slings slipped off and the sinker was released.

Sands' cup was the next device brought into use in the Navy and Coast Survey, but Brooke's apparatus was in general use until the "Hydra" machine as improved by Staff Commander Baillie, R. N., was adopted.

The Fitzgerald machine was used to some extent in the British navy.

The next marked improvement is due to Capt. Geo. E. Belknap, U. S. N., who while in command of the U. S. S. Tuscarora made the most remarkable series of deep-sea soundings on record. Following in his footsteps Lieut.-Comdr. C. D. Sigsbee, U. S. N., made some modifications in the Belknap cylinder, and added to it a detaching trigger of his own, reducing it to its present form as shown in the plate.

If the various types of sounding cylinders and detachers made since Brooke's invention became known were examined, it would be seen that they are all modifications of his system, as in sounding with wire all recent improvements in that direction have been modifications of Sir William Thompson's admirable system.

NOMENCLATURE.

a. Cylinder.
b. Screw joint.
c c. Upper and lower guide stem.
d. Cylindrical ring.
e. Valve seat.
f. Poppet valve.
g. Valve stem.
h. Spiral valve spring.
i. Hollow cone.
j. Perforated plate.
k. Swivel.
l. Pawl.
m. Tumbler.
n. Spring.
p. Apertures for escape of water.
q. Sinker.
r. Iron wire bail.

A longitudinal sectional elevation of Sigsbee's detacher and his modification of Captain Belknap's sounding cylinder No. 2 is shown in Fig. 1; a side view is seen in Fig. 2, with the sinker hung. Fig. 3 shows a plan view of the cylinder and a longitudinal sectional elevation of the detacher. Fig. 4 shows a back view of the detacher. The perforated plate *j* and cylindrical ring *d* are shown in Fig. 5, and an enlarged view of the hollow cone *i*, cylindrical ring *d*, apertures *p* for the escape of water, and the upper end of the cylinder *a* are shown in Fig. 6.

The cylinder *a* (Fig. 1) is attached rigidly to the guide stem *c*, the poppet valve *f* is on its seat at *ee*, and the hollow valve stem encircles the guide stem *c*, and is held in place by the spiral valve spring *h*. The hollow cone *i* moves freely on the upper guide stem; *dd* is a cylindrical ring forming the base of the cone *i*, and, when raised during the descent of the sinker, as in Fig. 1, it permits the water to flow freely from the cylinder through the apertures *pp* into the cone at *dd* and out at *pp*; but during the ascent it rests on the top of the cylinder *a*, closing the apertures (Fig. 6) against all outward pressure.

To take a sounding and bring up a specimen of the bottom, bend the stray line to the swivel *k*, slip the sinker on and hook the bail *r* on the tumbler *m*; lock the pawl and tumbler and suspend the weight of sinker and sounding rod from *k*, where it will remain until the weight is relieved by the sinker striking the bottom. The pawl will then assume a horizontal position from its own weight (Fig. 3); the tumbler will be thrown out of action by the spring *n*, assisted by its excess of weight at the point of contact with the bail *r*, thus releasing the sinker.

When the cylinder strikes the bottom, the valve *f* will be forced up, and more or less of the interior space of the cylinder will be filled with a specimen of the bottom soil. As soon as the ascent begins the valve *f* reseats itself, and, the apertures at the top being closed, the specimen is hermetically sealed. On reaching the surface it is removed by unscrewing the cylinder at *b*.

This apparatus has performed its work perfectly; in fact it has never failed to detach the sinker and bring up a specimen when the bottom was reached. They were furnished by D. Ballauf, Washington, D. C., at $15 each.

SINKERS.

All soundings exceeding the capacity of an ordinary hand lead-line are made with wire; in depths of over 2,000 fathoms a 60-pound detachable sinker is used; between 1,000 and 2,000, a 35-pound sinker, also detachable; and from 500 to 1,000 fathoms, an ordinary 35-pound ship's lead is used and reeled back. In depths less than 500 fathoms lighter leads, from 18 to 25 pounds weight, are used and reeled back, the bottom specimen being brought up by the arming.

The detachable sinkers are made of cast iron and are furnished by the ordnance department, navy-yard, Washington, D. C., fitted and bailed ready for use.

SIGSBEE'S WATER-SPECIMEN CUP (PLATE XXXIV).

The Sigsbee water-specimen cup, or water bottle, is designed to bring a specimen of water from any desired depth for the purpose of analysis or to determine its specific gravity. The valves are closed mechanically and cannot be opened again, except by hand, therefore these cups may be used in series, any desired number being sent down on the same line.

NOMENCLATURE.

a. Cylinder.
b. Lower valve seat.
c. Detachable upper valve seat.
d. Upper poppet valve.
e. Lower poppet valve.
f. Valve stem.
g. German silver compression spring.
h. The frame
i. German silver removable sleeve.
j. Brass pin.
k. German silver shaft.
l. Screw thread (44 to the inch).
m. Screw thread (44 to the inch).
n. German silver propeller.
o. Hub.
p. Inside screw thread (44 to the inch).
q. Guide cap.
r. Beveled lugs.
s. German silver bushing.
t. German silver screw cap with milled head.
u. Beveled slots.
v. Inside screw thread.
w. Clamp lugs.
x. Clamp pivot screw.
y. Phosphor bronze clamp wire.

The water bottle is made of brass, except such parts as are mentioned as being made of other metals.

The following remarks upon its working are taken from Sigsbee's Deep-sea Sounding and Dredging:

"To adjust the valves hold the upper valve firmly, and unseat the lower valve by screwing it upward," the key (Fig. 5) being applied to the lower end of the valve stem *f* for the purpose. "Then maintaining the upper valve on its seat with the finger, or better by turning the screw cap down upon it, reseat the lower valve gently. In general it will be necessary to adjust the valve only after the cup has been taken apart for cleaning or other purposes.

"The cup when in use comes to the surface filled with water, the screw cap pressing upon the upper valve, thus securing both valves, and the propeller resting upon the screw cap. To remove the specimen from the cup first lift the propeller, and by giving it a few turns cause its threads to engage the screw threads on the shaft; then turn up the screw cap until it uncouples. With the cap in this condition the valves

may be lifted and the water discharged. When the screw cap is pressing upon the upper valve the threads inside the former are engaged with the threads of the shaft, but on screwing up the cap, when its lower thread clears the upper thread of the corresponding series on the shaft, the cap is uncoupled, which prevents any mistake being made at this point by the person handling the cup; afterwards the screw cap may be turned in the same direction indefinitely without jamming or changing its position on the shaft.

"With the screw cap up and the propeller in any position, the cup is automatic, and may, if desired, be lowered into the water with no other preparation; yet it is a good practice first to screw up the propeller by hand to observe if the threads are in perfect working order. Assuming the propeller to be low down on the shaft, or even resting upon the screw cap, the action of the water is as follows:

"As it descends, the valves are lifted and held up by the resistance of the water; by the same agency the propeller is revolved and carried upward until, like the screw cap, it is uncoupled, after which it revolves freely on the shaft, impinging against the German silver sleeve *i*. If the propeller hub is allowed to come in contact with the sleeve while the screw threads are still engaged, it may remain impacted during the subsequent ascent. To insure uncoupling at the proper time the guide cap which fits over the top of the hub must be set well home in its position, when the propeller is fitted to its shaft. It will be noticed that the blades of the propeller are bent along their upper edges. With the blades thus bent, and all parts of the propeller made very light in weight, it has been found experimentally that the alternating movement of translation imparted to the submerged cup by the vessel's motion in a sea-way will cause the propeller, when engaged with the threads on the shaft, gradually to screw up rather than down. This shows that stoppages in the descent, whether to attach additional cups to the rope or wire, or for any purpose whatever, may be made with safety if the vessel is kept idle in the water, that is, without headway or sternboard. Were the blades not bent it is evident that the propeller would gradually screw down by the same alternating movement, since its weight would assist its action in screwing down, but resist the opposite motion. Even thus experiments have shown that with the alternating movement continued for a longer time than would probably be occupied by any stoppage, the propeller would screw down on the shaft only a small proportion of the distance to the screw cap. It is plain that in the event of such action the propeller would rise and uncouple each time the descent was continued. However, the bending of the blades insures safety, and the valves are left free to open during the whole descent. At any stoppage in the descent each cup contains within its cylinder a specimen of the water from its locality at the time being, allowing a margin of 1 or 2 feet.

"As soon as the ascent is begun the valves of each cup are pressed

firmly on their seats by the resistance of the water, and each propeller begins to screw down along its shaft under the same influence. When the upper thread inside the hub of the propeller clears the lower corresponding thread on the shaft the propeller uncouples, and drops upon the screw cap, which it clutches. The screw cap is then carried down until it comes in contact with the upper valve, from which position it cannot be removed by the action of the water or of the propeller. Both valves being thus locked, stoppages may be made thereafter during the ascent without risking the identity of the inclosed specimen of water.

"The distance through which the cup must pass, in order that the propeller may traverse the shaft and lock the valves, may be varied by altering the pitch of the propeller. As shown in the drawing the propeller would probably not perform its work short of 50 fathoms. I settled on about 25 fathoms as the distance most convenient. With this distance it would not be prudent to require the uppermost cup to bring a specimen from nearer the surface than 50 fathoms. If the propellers were arranged to lock the valve in an ascent of about 25 fathoms, and the uppermost cup were lowered only to a depth of 10 fathoms, for instance, obviously, when that cup had arrived at the height of the vessel's deck, the submerged cups, having passed through a distance of only about 12 fathoms, would not have become locked. Each cup, as soon as discharged, should be thoroughly rinsed in fresh water."

We have found these bottles to work satisfactorily for the purpose of collecting water specimens for specific gravity determinations; but they will not retain the gases, and are therefore not available for collecting specimens for chemical analysis.

Experience has taught us that it is advisable to reset the valves whenever the bottles are to be used, as their adjustment is liable to be impaired in releasing the screw cap from contact with the upper valve. Although Sigsbee states in the remarks quoted that the upper valve seat is detachable for purposes of cleaning, we find in practice that the accumulation of verdigris on the screw threads makes its safe removal impracticable. The valves and valve seats can be readily cleaned, however, without detaching the upper valve seat.

IMPROVED WATER BOTTLE.

The improved water bottle, Plates XXXV, XXXVI, and XXXVII, is designed to bring up a specimen of water from any desired depth, retaining the free gases for the purpose of analysis. The valves close mechanically and cannot be opened again except by hand; therefore it may, like the Sigsbee water specimen cup, be used in series, either with others of the same kind or with any instrument that can be used in series.

NOMENCLATURE.

a. Cylinder.
b b. Frame.
c c. Clamps to secure apparatus to temperature rope.
d. Expansion chamber.
e. Cock.
f f. Guards.
g g. Propellers.
h h. Shafts.
i i. Sleeves.
j j. Guys.
k k. Slots.
l l. Valves.
m m. Valve seats.
n n. End pieces.
o o. Spanner holes.
p p. Spanner holes.
q q. Set screws.
r r r. Stay rods.
s s. Inner arms of propeller frames.
t t. Outer arms of propeller frames.
u u. Cylinder clamp.
v v. Pin for cylinder clamp.

All parts of this water bottle are of brass, except the propeller blades, which are of German silver. The cylinder is a tube of commercial pattern; the frames, valves, valve seats, &c., are cast brass.

PREPARATION FOR USE (PLATE XXXVI).

Cleanse the inside of the cylinder from all foreign substances, particularly verdigris, oil, or red lead, which is sometimes used for making joints. Clean the valve faces and valve seats with a soft cloth, avoiding brick-dust, emery paper, or other scouring substances, as the valves are very carefully ground in and any scratch on their faces renders them liable to leak.

The valve seats should be removed for cleaning and replaced again, using spanners in the holes *o p* for the purpose, and to insure tight joints without undue strain a little red lead may be used on the shoulder between *m* and *n*.

In cleaning the cylinder particular attention should be given to the cock *e* and the expansion chamber *d*.

The propellers should be examined to see that they work freely on the sleeves and the supporting screws on their outer extremities. The shafts should be run up and down by means of the milled heads at *k*, to ascertain if the screw threads work freely and the shafts move on their bearings without undue friction.

The propellers should then be moved outward until they clear the supporting screws, where they will revolve freely during the descent without moving the shafts or in any way affecting the valves. The shafts should then be screwed inward a little to allow free connection with the valve stems *l*.

The cylinder may now be placed in the frames *b*, the valve stems *l* connected with the shafts *h*, and the cylinder secured in place by the clamps *u* and the pins *v* (Plate XXXVII). The valves should then be opened inwards to their full extent by means of the milled head at *k*. Secure the bottle to the rope by the clamps *c* (Plate XXXV), with the expansion chamber pointing upwards, and it will be in readiness for use.

TO OBTAIN A SPECIMEN OF WATER.

The dredge rope is used, having a sinker weighing 150 pounds. The apparatus being clamped to the rope a few fathoms above the sinker, lower away as rapidly as desired to the intended depth, and in case of temperature instruments not having been sent down, reel in at once.

The propellers now being brought into action soon close the valves.

The internal pressure which takes place as the apparatus ascends is relieved by the expansion chamber *d*. As soon as the bottle reaches the surface the valves are keyed to their seats through slots in the valve stems *l*. The cylinder is then removed from the frame and stowed in some cool place in a vertical position until such time as it can be delivered to the laboratory.

A vertical position is recommended in order to retain water on both sides of the piston in the expansion chamber to avoid possible drying and shrinkage of the packing.

TAKING CARE OF THE BOTTLE.

The water specimen having been procured and the cylinder removed, rinse the frame in fresh water and wipe it dry. Remove the set screws *q* and the shafts *h*, wipe them dry, and put a little oil on the screw threads.

Unscrew the sleeves *i* from the hubs of the propellers, wipe them dry inside and out, and oil them; wipe the propellers dry also and oil the inside of the hubs. Oil should be used sparingly, taking care that it does not drip into the cylinder.

Having cleaned and oiled the parts put them together and stow the frame in its packing box, which should be kept in a dry place.

As soon as the specimen has been removed from the bottle the latter should be rinsed in fresh water, the valve seats unscrewed, and the cylinder with its attachments carefully cleaned and dried as directed in its preparation for use. After the parts are put together clamp the bottle in the frame. Oil should never be used on the cylinder or its attachments.

ORIGIN OF THE IMPROVED WATER BOTTLE.

This water bottle as figured is the joint production of Dr. J. H. Kidder, of the United States Fish Commission; Surgeon J. M. Flint, United States Navy, attached to the United States Fish Commission steamer Albatross; and the writer.

It will be readily observed that it is a modification of the Sigsbee water specimen cup. The latter is well adapted for its purpose of collecting water specimens for specific gravities, but it will not retain the free gases in water intended for chemical analysis. Feeling the want of a bottle that would accomplish this desired end, Drs. Kidder and Flint devised one during the summer of 1884, which was made by D. Ballauf, of Washington, D. C., and sent to the Albatross for trial, and, after testing it, a few improvements suggested themselves to the writer and are embodied in the bottle figured.

We consider this bottle still in the experimental stage, although it has been very carefully constructed and has successfully withstood a pressure of 150 pounds per square inch. It is a well-known fact, however, that mechanism does not work as well under water as in the atmosphere, yet we anticipate good results from the apparatus in its present form.

THE NEGRETTI & ZAMBRA DEEP-SEA THERMOMETER.

The following description of this thermometer is copied, in part, from the catalogue of Negretti & Zambra, various eliminations and additions being made by the writer.

The construction of this thermometer will be readily understood by referring to Plate XXXVIII, Fig. 2, where it is shown in a vertical sectional elevation of Tanner's improved deep-sea thermometer case.

The thermometrical fluid is mercury; the bulb containing it is cylindrical, contracted in a peculiar manner at the neck *a*; and upon the shape and fairness of this contraction the success of the instrument mainly depends. Beyond *a* the tube is bent and a small catch reservoir at *b* is formed for a purpose to be presently explained. At the end of the tube a small receptacle *c* is provided. When the bulb is downward the glass contains sufficient mercury to fill the bulb, tube, and a part of the receptacle *c*, leaving, if the temperature is high, sufficient space in *c*. When the thermometer is held bulb upward the mercury breaks at *a*, but by its own weight flows down the tube filling *c* and a portion of the tube above *c*, depending upon the existing temperature. The scale is accordingly made to be read upward from *c*.

To set the instrument for observation it is only necessary to place it bulb downward, when the mercury takes the temperature just as in an ordinary thermometer. If at any time or place the temperature is required, all that has to be done is to turn the thermometer bulb upward and keep it in this position until the reading is taken. This may be done at any time afterward, for the quantity of mercury in the lower part of the tube which gives the reading is too small to be sensibly affected by a change of temperature, unless it is very great; while that in the bulb will continue to contract with greater cold and to expand with greater heat. In the latter case some mercury will pass the contraction *a* and may fall down and lodge at *b*, but it cannot go

further so long as the bulb is upward, and thus the temperature to be read will not be affected.

Now, whenever the thermometer can be handled it can readily be turned bulb upward for reading the existing temperature. It must be clearly understood that this thermometer is only intended to give the temperature at the time and place where it is turned over; it is simply a recording thermometer. In its present state it cannot be used as a self-registering maximum and minimum, though, if required, it could be constructed to act as a maximum.

In order to make the thermometer perfectly satisfactory, it was necessary to protect it from pressure as well in shallow as in the deepest seas, for in either case the pressure would cause an error of greater or less degree in its indications. Like an ordinary thermometer it is devoid of air, and so quite different from Sixe's, which, containing compressed air, has a certain internal resistance. Hence it would be more affected by pressure than Sixe's thermometer, however thick the glass of the bulb. By the simple expedient of inclosing the thermometer in a glass shield, *e*, hermetically sealed, the effect of external pressure is entirely eliminated. The shield must of course be strong, but not exhausted of air. It will, however, render the inclosed thermometer less readily affected by changes of temperature, making it more sluggish.

To counteract this tendency mercury is introduced into that portion of the shield surrounding the bulb, and confined there by a partition, *d*, cemented in the shield around the neck of the thermometer bulb. This mercury acts as a carrier of heat between the exterior of the shield and the interior of the thermometer; and the efficacy of this arrangement having been experimentally determined, the instrument has been found far superior in sensibility to Sixe's.

So long as the shield withstands the pressure—that is, does not break—the thermometer will be unaffected by pressure, and there is abundant experience to show that such a shield will stand the pressure of the deepest ocean. Doubtless the shield will be slightly compressed under great pressure, but this can never cause an internal pressure sufficient to have an appreciable effect upon the thermometer. This method of shielding is, therefore, quite efficacious, and deep-sea thermometers so protected do not require to be tested for pressure in the hydraulic press. They simply require accurate tests for sensitiveness and for errors of graduation, because they are standard instruments adapted to the determination of very small as well as great differences in temperature, some one or two tenths of a degree in shallow water. The test for sensitiveness should determine the time the instrument requires to take up a change of 5°, rise or fall, and the time is found to be from five to ten seconds.

Thus, provided the turning-over gear is found to answer, this instrument evidently possesses great advantages. It has no attached scale, the figures and graduations being distinctly marked on the stem itself,

and the shield effectually preserves them from obliteration. The part of the stem which forms the background to the graduations is enameled white to give distinctness to the mercury.

To make this instrument available for deep-sea use it is necessary to provide some reliable method of turning the bulb upward at the proper time; also, to prevent it from turning down again before the surface is reached and the temperature read.

Plate XXXVIII shows a metal frame devised by Commander Magnaghi of the Italian navy. It is described as follows in an advertisement of Messrs. Negretti & Zambra:

NEGRETTI & ZAMBRA'S PATENT IMPROVED FRAME STANDARD DEEP-SEA THERMOMETER.

"The apparatus will be best understood, short of inspection, by reference to Plate XXXVIII, Figs. 1 and 2. A is a metallic frame in which the case B containing the thermometer is pivoted upon an axis H, but not balanced upon it. C is a screw-fan attached to a spindle, one end of which works in a socket D, and on the other end is formed the thread of a screw E, about half an inch long, and just above it is a small pin or stop, F, on the spindle. G is a sliding top-piece against which the pin F impinges when the thermometer is adjusted for use. The screw E works into the end of the case B, the length of play to which it is adjusted. The number of turns of the screw into the case is regulated by means of the pin and stop-piece. The thermometer in its case is held in position by the screw E and descends into the sea in this position (Fig. 1), the fan C not acting during the descent because it is checked by the stop F. When the ascent commences the fan revolves, raises the screw E, and releases the thermometer which then turns over and registers the temperature of that spot, owing to the axis H being below the center of gravity of the case B as adjusted for the descent. Each revolution of the fan represents about 2 feet of movement through the water, so that the whole play of the screw requires 70 or 80 feet ascent; therefore, the space through which the thermometer should pass before turning over must be regulated at starting. If the instrument ascends a few feet by reason of a stoppage of the line while attaching other thermometers, or through the heave of the sea, or any cause whatever, the subsequent descent will cause the fan to carry back the stop to its initial position, and such stoppages may occur any number of times provided the line is not made to ascend through the space necessary to cause the fan to release the thermometer.

When the hauling in has caused the turn-over of the thermometer the lateral spring K forces the spring L into a slot in the case B and clamps it (Fig. 2) until it is received on board, so that no change of position can occur in the rest of the ascent from any cause.

The case B is cut open to expose the scale of the thermometer, and is also perforated to allow free entry of the water."

The thermometer (Fig. 3) has already been described.

The Magnaghi frame above described is a great improvement on the wooden cases formerly furnished by the makers, but even this did not prove entirely satisfactory in all respects, inasmuch as it could not be secured to sounding wire, and could not, therefore, be used in series. The fan failed to act occasionally, and the springs K and L were apt to hold the case B in a vertical position by friction, thus preventing the turn-over at the proper time.

Various devices have been used on the vessels of the commission for capsizing the thermometer; the Tanner case and the Bailie-Tanner case, described in former reports, were, however, the most successful. They were used with good results until the peculiar service of the Albatross demonstrated the necessity for some arrangement by which the thermometers could be used in series either on the sounding wire or the dredge rope, which is frequently used as a temperature rope. It was desirable also to reduce the weight and resistance as much as possible. We were troubled occasionally by the mercury shaking down from the catch reservoir into the tube, thus vitiating the reading. This was the result of jars of one kind or another. The speed of 600 to 800 feet per minute at which the sounding wire was hove in by steam was a fruitful source of trouble, causing great vibration, which was complicated by the jars incident to the rapid passing of centers by the single cylinder reeling engine. These difficulties were subsequently overcome in the manner hereafter described.

THE TANNER IMPROVED THERMOMETER CASE WITH THE SIGSBEE CLAMP, USED WITH THE NEGRETTI-ZAMBRA DEEP-SEA THERMOMETER (PLATE XXXIX).

Fig. 1 shows the apparatus complete, and Fig. 2 a vertical sectional elevation of the metal case containing the thermometer.

NOMENCLATURE.

a. Neck of the bulb.
b. Catch reservoir.
c. Small receptacle.
d. Partition confining mercury in shield surrounding bulb.
e. Glass shield inclosing thermometer.
f. Thermometer case.
g. Thimble with rubber lining.
h. Spiral springs.
i. Cap.
j. Pivot.
k. Slot for reading scale.
l. Frame of cast brass.
m. Guard.
n. Propeller.
o. Spindle.
p. Set screw.
q. Sigsbee clamp.

The entire apparatus is made of brass except the Sigsbee clamp, which is of phosphor bronze, and the rubber linings of the thimbles *g*.

To mount the thermometer unscrew the cap *i*, drop a spring *h* into the case, slip a thimble *g* over the glass shield at *d*, put the thermometer in the case, drop in another thimble, which will rest on the upper end of the shield, then place another spring on the thimble and screw the cap in place. The thermometer will then be suspended between delicate spiral springs at the ends and soft rubber rings which surround the shield. This arrangement has proved effectual in guarding the thermometer against jars incident to the service required of it on board of the Albatross.

To take a temperature set the spindle *o* into the hole in the cap *i* by screwing it down until the propeller blades strike the set screw *p*; then by means of the Sigsbee clamp *q* secure it to the temperature rope. The bulb will then be down and the mercury in the tube connected with it, the position required to take the temperature. The water acting on the propeller during the descent will keep it in position resting against the set screw *p*, but as soon as the reeling in begins the propeller is set in motion, bringing the screw on the upper end of the spindle into action, gradually raising the propeller until the lower end of the spindle is withdrawn from the hole in the cap *i*, when the thermometer promptly turns over and registers the temperature by breaking the column of mercury at the point *a*, the column then falling to the bottom of the tube.

It can be read at any time afterward, as changes of temperature do not affect the reading after the column is once broken.

The apparatus described above is simple and reliable.

THERMOMETERS FOR AIR AND SURFACE TEMPERATURES.

These thermometers are made by J. & H. J. Green, New York. The tubes are 10 inches in length, extra strong, and the scales are distinctly marked on them. Two-tenths of a degree is the greatest error found in testing them.

THE MILLER-CASELLA DEEP-SEA THERMOMETER.

Plate XL shows this thermometer in the copper case used for deep-sea work; also partially dismounted to show the form of construction. The magnet seen between the two instruments is used to adjust the indices.

The following description is from Sigsbee's Deep-sea Sounding and Dredging:

"A glass tube bent in the form of U is fastened to the vulcanite frame, and to the latter are secured white glass plates containing the graduated scales. Each limb of the tube terminates in a bulb. A column of mercury occupies the bend and a part of the capillary tube of each limb.

The large bulb and its corresponding limb above the mercury are

wholly filled with a mixture of creosote and water; the opposite limb above the mercury is partially filled with the same mixture, the remaining space therein being occupied by compressed air. In the mixture, on each side, is a steel index having a horse-hair tied around it near the upper extremity. The ends of the elastic horse-hair, being held in a pendant position by the inner walls of the tube, exert enough pressure to oppose a frictional resistance to a movement of the index in elevation or depression. As thus described, the instrument is a self-registering maximum and minimum thermometer for ordinary use. The indications are given by the expansion and contraction of the creosote and water mixture in the large full bulb.

"The instrument is set by bringing the lower end of the indices in contact with the mercury by means of a magnet provided for the purpose. Then, when the instrument is submitted to a higher temperature, the expansion of the mixture in the large bulb depresses the column of mercury on that side, and correspondingly elevates it on the other side. A decrease of temperature contracts the mixture in the large bulb, and by the elastic force of the compressed air in the smaller bulb, a transference of the column of mercury takes place in precisely the reverse manner to that which occurs on a rising temperature. Thus the mercury rises in the left limb for a lower, and in the right limb for a higher, temperature. The greater the change of temperature the higher the point reached in the respective limbs; hence the scale on the left is graduated from the top downwards, and that on the right from the bottom upwards. The rising of the mercury in either limb carries with it the index of that limb, and on the retreat of the mercury the index remains at the highest point attained. The bottom of the index, being the part which has been in contact with the mercury, gives the point at which to take the reading."

The large bulb of this thermometer is now protected from pressure by a glass shield which surrounds it; the space between the shield and bulb is nearly filled with alcohol, which acts as a transmitting medium for temperature performing the same function as the mercury in the shield of the Negretti & Zambra thermometer. The shield above mentioned has added much to the value of the instrument, as it has practically eliminated errors arising from varying pressures. This thermometer has been considered the standard for deep-sea work, and when several were to be sent down to great depths on the same line it was unrivaled until the present improvements in the methods of capsizing the Negretti & Zambra thermometers were introduced.

It is not as sensitive as the Negretti & Zambra, but under the above conditions a delay of a few minutes is not of great importance. The movable indices are a fruitful source of annoyance and vexatious delay. An index may, without an apparent cause, absolutely refuse to move in the tube; coaxing with the magnet is followed by lightly tapping the

frame in the hand or swinging it rapidly about the head; and if this fails more vigorous tapping is apt to follow with various active measures, none of which tend to improve the general condition of the instrument.

The indices are also liable to move if the instrument is subjected to rough treatment, although this is not of frequent occurrence with careful handling. Most of the minor casualties to which the instrument is liable are apparent to the eye and are readily adjusted.

WATER DENSITIES.

Hilgard's ocean salinometer (Plate XLI) is used on board of the Albatross for observing the density of sea-water.

An excellent description of the apparatus is given by Prof. J. E. Hilgard in the United States Coast Survey Report for 1874, and reproduced in Sigsbee's Deep-sea Sounding and Dredging, as follows:

"The density of sea-water in different latitudes and at different depths is an element of so great importance in the study of ocean physics as to have caused a great deal of attention to be paid lately to its determination. The instruments employed for the purpose have been, almost without exception, areometers of various forms. The differences of density as arising from saltness are so small that it is necessary to have a very sensitive instrument. As the density of ocean water at the temperature of 60° Fahr. only varies between the limits 1.024 and 1.029, it is necessary, in order to determine differences to the hundredth part, that we should be able to observe accurately the half of a unit in the fourth decimal place. This gives a great extension to the scale, and involves the use of a series of floats if the scale starts from fresh water, or else the instrument assumes dimensions which make it unfit for use on board ship. With a view to the convenient adaptation to practical use this apparatus has been devised for the Coast Survey by Assistant Hilgard.

"The instrument consists of a single float about 9 inches in length. The scale extends from 1.020 to 1.031, in order to give sufficient range for the effect of temperature. Each unit in the third place, or thousandths of the density of fresh water, is represented by a length of 0.3 of an inch, which is subdivided into five parts, admitting of an accurate reading of a unit in the fourth place of decimals by estimation.

"The float is accompanied by a copper case, with a thermometer inserted within the cavity, which is glazed in front. In use the case is nearly filled with water, so as to overflow when the float is inserted, the reading then being taken with ease at the top of the liquid.

"For convenience and security, two such floats and a case are packed together in a suitable case, and a supply of floats and thermometers securely packed in sawdust is kept on hand to replace the broken ones.

"The following table has been derived from the observations of the

expansibility of sea-water made by Prof. J. S. Hubbard, U. S. N. Column II contains a reduction for temperature of salinometer readings to the standard of 60° Fahr. To facilitate the use of this table the following directions are given:

"Record the actual observation of hydrometer and thermometer. From column II (which is applicable to any degree of saltness within the given limits) take the number corresponding to the observed temperature and multiply this number by the number of degrees and fractions of a degree that the observed temperature differs from 60°. Apply this product as a correction, with proper sign, to the reading of the salinometer, and the result will be the reading of the salinometer at the standard temperature of 60° Fahr.

"EXAMPLE.—Actual reading of thermometer=80°.5; actual reading of salinometer=1.02425.

"Opposite 80.°5 in column II is +0.0001585, which, multiplied by 20.5, gives as a product +0.003249. Add this to the observed reading of salinometer, and 1.02750 will result as the reading of the salinometer at the standard temperature.

Temperature.	Coefficients for reduction to 60°.	Temperature.	Coefficients for reduction to 60°.	Temperature.	Coefficients for reduction to 60°.	Temperature.	Coefficients for reduction to 60°.
°		°		°		°	
50	−0.000108	60	+0.000000	70	+0.000145	80	+0.000158
51	−0.000110	61	+0.000130	71	+0.000146	81	+0.000159
52	−0.000112	62	+0.000135	72	+0.000147	82	+0.000160
53	−0.000113	63	+0.000137	73	+0.000148	83	+0.000162
54	−0 000115	64	+0.000137	74	+0.000149	84	+0.000163
55	−0.000118	65	+0.000138	75	+9.000151	85	+0.000164
56	−0.000120	66	+0.000140	76	+0.000152	86	+0.000166
57	−0.000120	67	+0.000141	77	+0.008154	87	+0.000167
58	−0.000120	68	+0.000142	78	+0.000156	88	+0.000168
59	−0.000120	69	+0.000143	79	+0.000157	89	+0.000170

"A method quite different in practice for determining the density of sea-water has been suggested by Prof. Wolcott Gibbs, of Harvard University. It depends upon the determination of the index of refraction by means of an angular instrument similar to the sextant. As all navigators are familiar with the use of the sextant, and as the observation can be made without hindrance from the motion of the ship, this form of the instrument may be found to possess certain advantages.

"NOTE IN 1876.—When the table of reductions for temperature above given was constructed, the investigations relative to the same subject made by Thorpe and Rücker (Royal Society's Proceedings, January, 1876) were not known. The following comparison of the results of the experiments on the thermal dilation of sea-water, as taken from Professor Hubbard's tables, and as derived from the results of Thorpe and Rücker,

shows the differences within the range of temperature covered by our table of corrections:"

Temperature.	Volume.	
	Hubbard.	Thorpe and Rucker.
°		
50	0.99895	0.99902
55	0.99943	0.99946
60	1.00000	1.00000
65	1.00067	1.00059
70	1.00142	1.00127
75	1.00221	1.00205
80	1.00309	1.00280
85	1.00402	1.00364

Plate XLII shows the bow of the Albatross with the sounding machine and dredging boom in position.

The Sigsbee deep-sea sounding machine *a* on the port side of the topgallant forecastle is shown in readiness for taking a sounding.

The working reels containing the sounding-wire are kept in the galvanized-iron tanks *b b* when not in use. Each tank contains sufficient sperm-oil to cover the reel.

The Tanner sounding machine *c* is shown in position on the port rail forward of the fore rigging.

The dredging boom *h* is shown in position for dredging. It is made of spruce, 36 feet in length and 10 inches in diameter, with brass fittings at the ends. The heel pivots in a heavy composition band on the foremast, and the head is held in position by the topping-lift *l* and the guys *m m*.

A beam trawl *d* is shown ready for lowering. The wing nets *e e* are shown in place. The bridle *f f* is seized to the eyebolts on the forward part of the runners, stopped lightly to their after ends, and lashed to the end of the trawl-net. The register *i* is attached to the heel of the boom, and is actuated by a worm wheel on the pulley shaft, thus indicating at all times the number of fathoms of dredge rope out.

The dredging block *g* is seen at the boom end; the accumulator, at *k;* the accumulator block, at *j;* the dredge rope, at *o o;* and the hoisting engine, at *n*.

When the dredging boom is not in use it is lowered, the forward end resting on the topgallant forecastle; the topping-lift is unshackled and secured abreast the foremast, and the guys unhooked and stowed away.

DREDGING BLOCK.

The dredging block used by the Albatross is shown in Plate XLIII, Figs. 1 and 2. The shell *a* is made of two pieces of bar iron ½-inch thick, 5½ inches in width at one end, 4½ at the other, and 3½ in the center.

They are bolted to a block of wrought iron $5\frac{1}{2}$ inches in length, $2\frac{1}{2}$ inches in width, and $2\frac{1}{2}$ inches in depth, having a hole $1\frac{3}{8}$ inches in diameter through its center in which the shackle bolt *d* is secured. This bolt acts also as a swivel. The sheave *b* is made of composition $21\frac{1}{2}$ inches total diameter, 18 inches at the bottom of the score, and $2\frac{1}{4}$ inches in width. The pin *c* is of cast steel, and is surrounded by six cast-steel friction rollers *i*, $1\frac{1}{4}$ inches in diameter, which work on the inner surface of a wrought-iron bushing in the sheave. The guards *h* are used on the block at the boom end, to prevent the dredge rope from flying out of the score, and the arm *j* is used on the accumulator block for the forward guy which hooks in the eye *k*. The absence of the guards *h* in one block, and the arm *j* in the other, constitute their only points of difference.

THE ACCUMULATOR.

The apparatus shown in Plate XLIV performs the double function of accummulator and dynamometer for the dredge rope.

NOMENCLATURE.

a. Buffers.
b. Washers.
c. Guide rods.
d. Tension rod.
e. Link.
f. Swivel link.
g. h. Lock nuts.
i. Cross-heads.
j. Yoke.
k. Tie.

The accumulator is shackled to the topping-lift band 13 inches below the futtock band on the foremast, and is suspended directly forward of the mast. Its total length, including the links *e* and *f*, is 11 feet 1 inch.

The guide rods *c c* are made of one piece of round mild steel, 1 inch in diameter, bent at *e* and *k*, with screw threads and lock nuts at *h h*. The tension rod *d* is also of mild steel, round in section, $1\frac{1}{4}$ inches in diameter, and 9 feet 9 inches net length, that is, measured inside the cross-head *i* and yoke *j*, and it will take thirty-nine buffers without compression. It has a swivel link at the lower end, to which the accumulator block shackles, and a screw thread and lock nuts *g* at the opposite extremity.

The cross-heads *i i i*, the yoke *j*, and the tie *k* are of wrought iron; the former move freely on the guide rods, the upper one receiving the end of the tension rod, and the others support the guide rods. Figs. 3 and 4 show a front and side view of a cross-head.

There is a brass washer *b* between each pair of buffers, separating them from each other, and keeping them from contact with the tension rod, as seen in Fig. 2, where the washer and buffers are shown in section.

The washers are 6⅜ inches in diameter, three-sixteenths inch thick, and have a hole in the center $1\frac{5}{16}$ inches in diameter. A hub one-half inch in length extends from each side of the washers (Figs. 5 and 6), except those in contact with the yoke and cross-heads, which have no hub on that side. The buffers were purchased of the New York Rubber Belting Company, and are composed of their compound No. 23. They are 5½ inches in diameter, 3 inches thick, have a hole $1\frac{7}{16}$ inches in diameter through their center, weigh 4 pounds 3 ounces, and cost 67 cents per pound, or about $2.80 each.

A scale not shown in the plate is lashed to one of the guide rods, and marked to indicate the strain on the dredge rope to each 500 pounds by compression of the buffers.

The accumulator is useful, not only to relieve sudden strains brought upon the dredge rope by the vessel's motion in a sea way, but it insures a more uniform action of the hoisting engine, and gives the first indication of increased tension on the rope in case the trawl fouls or buries in the soft bottom when working in deep water.

The hubs on the brass washers, which prevent the buffers from coming in contact with the tension rod, were devised by Lieutenant-Commander Sigsbee, U. S. N., on board of the United States Coast Survey steamer Blake. Previous to their introduction the buffers were liable to grip the tension rod while they were compressed, making the apparatus sluggish in its action, a fault that no longer exists. It is, on the contrary, exceedingly prompt in expansion after being relieved of its load, and retains its elasticity under all conditions of service and temperature.

THE DREDGE ROPE.

Our rope is made of galvanized steel wire, and was manufactured by the Hazard Manufacturing Company, Wilkesbarre, Pa., C. M. Thompson, agent, 87 Liberty street, New York. It is three-eighths inch in diameter and has six strands, laid around a tarred hemp heart. The strands are composed of seven wires, each made according to a special gauge of the manufacturers, approximating to No. 18 American or No. 19 Birmingham gauge. It weighs 1.32 pounds per fathom in air, about 1.2 pounds in water, and its ultimate strength determined by the testing machine at the ordnance department, navy-yard, Washington, D. C., is 12,850 pounds. A kink reduces the strength about 50 per cent.

We first received 4,000 fathoms in one length wound on a heavy wooden reel, from which it was transferred to the working reel. The spare rope was supplied in lengths of 1,000 fathoms, each length wound on a wooden reel. Subsequently the rope was ordered in 500 fathom lengths, the reels being much more convenient for stowage and lighter to handle.

When transferring this rope from one reel to another or when it is in use for trawling or dredging, it is absolutely necessary to keep it under tension, for if slacked from any cause it will kink, continuing to do so

until all the slack is absorbed. This is the one contingency that must be carefully guarded against in the use of this rope.

A "long splice" from 20 to 25 feet in length is used to join two pieces of rope. A man with an assistant will make a splice in about two hours, which, if well made, cannot be detected without close observation, and is as strong as other parts of the rope, at least we have found it to part quite as often away from the splices as at them.

We have used various forms of splice at the end of the rope and have finally settled upon an ordinary eye-splice turned around a large oblong thimble, the ends tucked three times, tapered, and trimmed the same as though it were a hemp or manila rope. We serve the splice occasionally with annealed iron wire when we wish to make a particularly neat job, but it is not at all necessary.

The rope being galvanized requires no preservation while new, but if from long service the zinc should be worn off and the steel wires exposed a coating of raw linseed oil will be of service. We have used no preservative, and have had no trouble from rusting.

SAFETY HOOKS.

The safety hooks (Plate XLV) are designed for the purpose of detaching the trawl or dredge when, from any cause, such as fouling a rock or burying in the soft ooze of the ocean bed, the tension on the dredge rope exceeds the limit of safety.

The rope is spliced into the eye *c*, the spiral spring is adjusted by means of the nut on the end of the tension rod *d*, then placed in the cylinder *a* and the cap *b* screwed on. The shoulders *f f* on the hooks will rest on the inner surface of the lower extremity of the cylinder *a*. The trawl being shackled by passing the pin through the hooks, and the necessary tension being put on it, the spring *e* will be compressed, the shoulders *f f* will extend below the end of the cylinder, and the hooks will open, allowing the shackle pin to slip between them, thus detaching the trawl and relieving the rope from undue strain. The spring can be adjusted to release the trawl at any point between 3,000 and 6,000 pounds.

THE DREDGING AND REELING ENGINES (PLATES XXIII, XXIV, and XXV).

A detailed description of these engines is given in the engineer department and need not be repeated. A brief mention of their design and construction may not, however, be out of place here.

During the summer of 1881, while the plans for the Albatross were being perfected, the writer examined every form of hoisting and reeling engine within reach, as well as models in the Patent Office and plans of engines constructed by various builders, but found nothing fulfilling our requirements. The type adopted on board the Fish Hawk, combining the hoisting and reeling engine, using the same drum for hoist-

ing the trawl and reeling up the rope, was considered; but it was evident that a reel of sufficient capacity for 5,000 fathoms of dredge rope, with strength to withstand the enormous crushing strain it would have to endure, would be too heavy and unwieldy for our purposes, and was consequently discarded.

Having finally recognized the necessity for two separate engines, one for hoisting and another for reeling, we decided to place the former on the spar deck, forward of the foremast, and the latter directly under it on the berth deck, for the double purpose of protecting the machinery and dredge rope from the weather, and placing the weight as low as possible in the vessel. Various plans were considered and rejected for one reason or another, until finally the writer submitted rough pencil sketches of the types considered by him as most nearly answering the requirements, to Mr. Earle C. Bacon, of Messrs. Copeland & Bacon, 85 Liberty street, New York.

He reduced them to proper proportions and perfected such parts as were left to his discretion. They were subsequently ordered from the above-mentioned firm and constructed under the personal supervision of Mr. Bacon. They have performed their work admirably.

THE GOVERNOR.

The hoisting engine being located on the spar deck, and the reeling engine on the deck below, entirely hidden from view, it became necessary to have some automatic device by which the movements of the latter would be governed by those of the former, not only to guard against parting the dredge rope, but to insure a uniform tension on it while being wound on the reel.

With that object in view the writer devised the governor (Plate XXV) described in connection with the reeling engine in the engineer department. The working drawings were made by Passed Asst. Engr. Geo. W. Baird, U. S. N., who superintended its construction. He also suggested attaching the bell crank to a pressure valve instead of the throttle, which is a great improvement, as it leaves the latter under control of the attendant at all times; and the former, once set to the desired tension, requires no further adjustment, and only occasional verification through the medium of a dynamometer.

DEEP-SEA TRAWL.

The deep-sea trawl frame (Plate XLVI) is a slight modification of "the standard trawl for deep-sea work, No. 1," described by Sigbee in Deep-sea Sounding and Dredging, p. 151. It is necessary for the successful operation of the beam trawl that it should land on the bottom right side up. The officers of the Blake, having experienced some vexatious delays from capsizing, devised a double trawl which worked equally well either side up, and was subsequently used on board that vessel with excellent results.

The following are the dimensions of the frame and net in use on board of this vessel:

Beams:

Iron pipe, length, 11 feet.

Outside diameter, 2¾ inches.

Thickness of metal, $\frac{3}{16}$ inch.

Collars, brass, width, 3 inches; thickness, ¾ inch; length of flange, 9½ inches; diameter of bolts, ¾ inch.

Runners:

Length, 4 feet.

Depth, 3 feet 6 inches.

Width, 3 inches.

Thickness, ½ inch.

Weight of frame, 275 pounds.

Rope for bridle, manila, 3 inches.

Rope for roping, manila, 2½ inches.

Trawl net:

Length, 17 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 30-thread.

Pocket:

Length, 6 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 21-thread.

Jacket:

Length, 6 feet.

Size of mesh, square, ½ inch.

Material, cotton, barked, 16-thread.

Bottom lining of cheese-cloth for deep-sea work.

The length of the net, including jacket and pocket, is given when it is mounted and on a stretch.

The runners are made of flat bar-iron with a small rod running around their inner surfaces to which netting is laced to fill the spaces and prevent the escape of fish, &c., from the trawl. The runners are tied together rigidly by two beams of wrought-iron piping having a brass collar screwed on each end. These are secured to the runners by screw-bolts.

The netting used for trawl and dredge nets, as well as pockets and jackets, is purchased by the bolt. The net is cut from the bolt, the width of which represents the length of the net; the edges are then joined by a seam running lengthwise on the upper side of the bag, forming an open-mouthed net which is roped with 2½-inch manila. That portion forming the loop, intended to drag on the bottom between the runners, is loaded at intervals with lead weights.

The pocket is stitched to the main bag about 3 feet below the lead rope, and the jacket is laced its width above the lower end of the net, so that the edges of both come together. The bag is attached to the rear ends of the runners by strong seizings at the four corners, leaving the lead ropes sufficiently slack for the upper one to touch the beam. A netting is usually stretched between the beams.

Floats are attached to the net a few feet from the lead rope by means

of a slack line, to prevent the upper part of the bag from falling and obstructing the mouth while dragging.

The bridle is practically the same as suggested by Sigsbee. Large eyes are spliced in the ends of a 3-inch rope, a thimble turned in the middle, and an overhand knot taken in each leg at the point of contact with the eyebolts on the front of the runners. Seizings are passed through the eyebolts and around the bridle legs forward of the knots, and the ends of the legs are securely lashed to the tail of the trawl net. Should the trawl foul on the bottom or take in a dangerously heavy load it is intended that the seizings shall part, and the trawl be drawn up tail foremost. The strength of seizings required for this purpose at the forward end of the runners is determined by experiment.

We have used the trawl described above with good results in deep water. It is not, however, adapted for use on the hard sandy bottom usually encountered in shoal water, for the reason that sufficient sweep cannot be given the lead rope. It has another fault which has practically driven it out of use on board of this vessel. It will be seen by reference to the plate that the mouth of the trawl will be extended equal to the depth of the runners while being hove up; consequently the wash of water through the meshes of the net must be very great; so great, in fact, that in a sea-way it often seriously injured the specimens.

BEAM TRAWL.

The beam-trawl frame, Plate XLVII, shows the form in use on board of this vessel, both for shoal and deep-water work.

The following are the dimensions of the frame and net:

Beam:
- Iron pipe, length, 11 feet.
- Outside diameter, $2\frac{3}{8}$ inches.
- Thickness of metal, $\frac{3}{16}$ inch.

Collars, brass, width, 4 inches; thickness, $\frac{3}{8}$ inch; length of flange, $9\frac{1}{2}$ inches; diameter of bolts, $\frac{3}{8}$ inch.

Runners:
- Length, 5 feet.
- Height, 2 feet 5 inches + 4 inches; total, 2 feet 9 inches.
- Width, 4 inches.
- Thickness of metal, $\frac{3}{8}$ inch.

Weight of trawl frame, 365 pounds.

Rope for bridle, 3 inches.

Rope for lead rope, 2 inches.

Rope for head rope, $1\frac{1}{2}$ inches.

Trawl net:
- Length, 17 feet.
- Size of mesh, square, 1 inch.
- Material, cotton, barked, 30-thread.
- Pocket, length, 6 feet.
- Pocket, size of mesh, square, 1 inch.
- Pocket, material, cotton, barked, 21-thread.
- Jacket, length, 6 feet.
- Jacket, size of mesh, square, $\frac{1}{2}$ inch.
- Jacket material, cotton, barked, 16-thread.

Bottom lining of cheese-cloth for deep-water work.

WING NETS.

Various forms of nets have been used to collect minute specimens at intermediate depths, but Capt. H. C. Chester was the first, I believe, to attach the net to the trawl frame. This he did by hanging a small cheese-cloth net to a piece of iron pipe, one end of which was inserted in

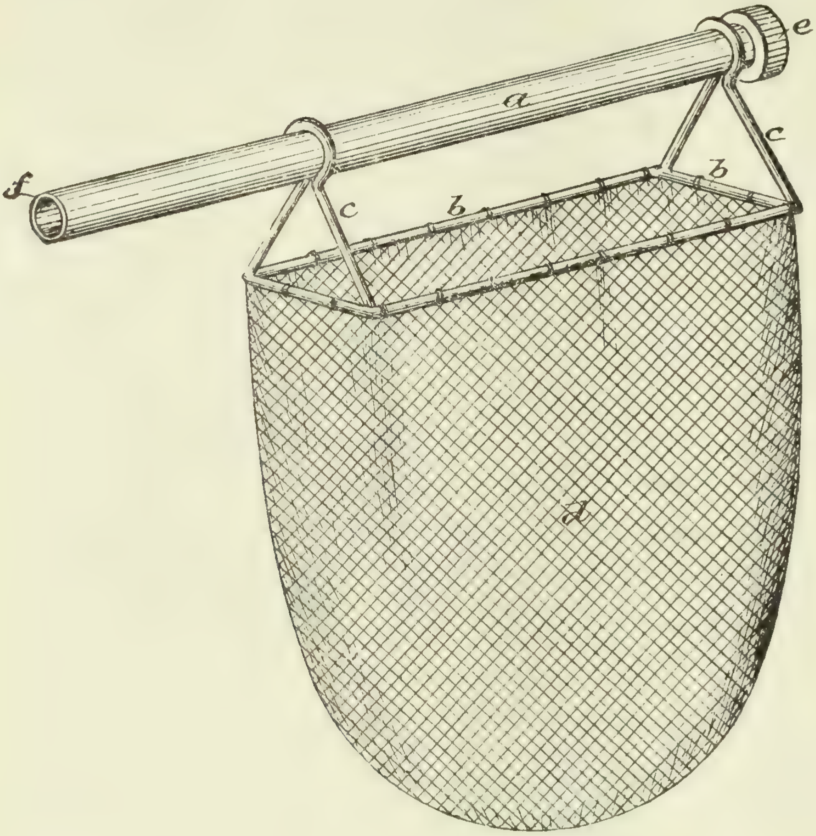


FIG. 19.—Chester's wing net.

the trawl beam, and held in place by a set screw. The iron pipe *a* has a ring *e* at its outer end to prevent the arms *c c* from slipping off. The arms, the frame *b*, and the net *d* are suspended from the pipe which is inserted into the end of the trawl beam at *f*. The arms swing freely on the pipe.

DIMENSIONS.

Iron pipe, *a*, length, 3 feet.
Iron pipe, *a*, diameter, 2 inches.
Iron cap, *e*, length, 1 inch.
Iron cap, *e*, diameter, $2\frac{7}{8}$ inches.
Frame, length, 2 feet.
Frame, width, 8 inches.
Frame, diameter, round iron, $\frac{1}{2}$ inch.
Arms, length, 6 inches.
Arms, diameter, round iron, $\frac{1}{2}$ inch.
Bag, length, 2 feet.
Bag, size of mesh, square, $\frac{3}{16}$ inch.
Bag, material, cotton, 3-thread.
Bag, bottom-lining, cheese-cloth.

Subsequently the bottom lining was discarded and an ordinary surface towing net inserted, the ring seized to the sides of the net *d*. This net has proved a valuable adjunct to the trawl.

MUD BAG.

The mud bag used by us with the trawl is simply a boat dredge with the net removed and the rear end of the canvas shield closed, making a water-tight bag. We lash this to the tail of the trawl net and usually find it filled with a compact mass of mud or ooze when it comes up. This affords many interesting specimens besides enabling us to determine the character of the bottom more accurately than we could by examining the small amount brought up in the specimen cup.

IMPROVED BEAM TRAWL.

This trawl, Plate XLVIII, was introduced by the writer in 1884* and is the latest form used on board the Albatross. It is a modification of the one shown in Plate XLVII.

NOMENCLATURE.

a. Beam, iron pipe.
b. Runners.
c. Trawl net.
d. Pocket.
e. Jacket.
f. Bridle.
g. Shackle.
h. Lashings.
i. Mud bag.
j. Lead rope.
k. Arms, wood.
l. Wing nets.
m. Guard nets.
n. Dredge rope.
o. Dredging block.
p. Dredging boom.
q. Bridle stops.
r. Collars, brass.

DIMENSIONS.

Beam:
- Iron pipe, length, 11 feet.
- Outside diameter, $2\frac{7}{8}$ inches.
- Thickness of metal, $\frac{3}{16}$ inch.

Collars:
- Brass, width, $3\frac{1}{2}$ inches.
- Thickness, $\frac{3}{4}$ inch.
- Length, $9\frac{1}{2}$ inches.

Bolts:
- Iron, round, diameter, $\frac{3}{4}$ inch.
- Set screws, in collars, iron, square heads, diameter, $\frac{5}{8}$ inch.

Runners:
- Iron, flat-bar, length, 5 feet.
- Height, 2 feet 5 inches.
- Height, including collars, 2 feet 9 inches.
- Width, $3\frac{1}{2}$ inches.
- Thickness of metal, $\frac{1}{2}$ inch.

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* Owing to delay in printing we are able to introduce this and other late improvements into this report.

Jackstays:

Iron, round, diameter, $\frac{1}{4}$ inch.

Eyebolts, brass; diameter of metal, $\frac{3}{8}$ inch.

Arms:

Wood, for wing nets, length, 2 feet 6 inches.

Wood, for wing nets, diameter, $2\frac{1}{2}$ inches.

Weight:

Frame, 275 pounds.

Bridle:

Rope, circumference, 3 inches.

Net:

Lead rope, circumference, 2 inches.

Head rope, circumference, $1\frac{1}{2}$ inches.

Length, 17 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 30-thread.

Pocket, length, 6 feet.

Pocket, size of mesh, square, 1 inch.

Pocket material, cotton, barked, 21-thread.

Jacket, length, 6 feet.

Jacket, size of mesh, square, $\frac{1}{2}$ inch.

Jacket material, cotton, barked, 16-thread.

Bottom lining of cheese-cloth for very deep water work.

It will be observed that there is no change in the beam, and the runners remain the same in height and length, but they are much reduced in weight and so modified in form as to avoid sharp angles in the net, thus equalizing the strain over its various parts and largely increasing its limit of safety.

The jackstays on the inner surfaces of the runners and the guard nets which are laced to them are not new, but we have confined their use heretofore to the small beam trawls and deep-sea trawls. There is no doubt that they prevent the escape of many fish and other quick moving objects.

The trawl-net is the same in every particular as that already described for the beam trawl, and the bridle is fitted and secured precisely in the same manner. The mud bag is also the same.

WING NETS.

The wing nets shown in Plate XLVIII were devised by the writer in 1884, and the pocket introduced to prevent the escape of specimens after having entered the nets. They are made of cheese-cloth in the following manner:

The material is laid on deck and folded once lengthwise, a pattern is then placed over it and the two halves cut from the piece at the same time; the side seams are sewed up, the ends hemmed, and one end turned in over a galvanized-iron ring, thus forming the pocket. The double bridle is seized to the ring through the net and serves to hold it in place. The lashing is stopped to the lower end of the net to prevent its loss when cast adrift. And to prevent the pocket from turning

wrong side out a small piece of twine, with a knot on its lower end, is allowed to hang down from it far enough to be gathered in with the end of the net and secured with the lashing.

The bridles are seized in scores cut in the arms for the purpose. When required for use the arms are inserted in the ends of the beam and held in place by the set screws in the collars.

DIMENSIONS OF WING NETS.

Galvanized-iron ring, diameter, 1 foot.
Galvanized-iron ring, diameter of iron, $\frac{3}{8}$ inch.
Net, length, 3 feet.
Pocket, length, 2 feet.

SMALL BEAM TRAWL.

The small beam trawl is used during bad weather, being easier to handle and bringing less strain on the dredge rope. The dimensions of the frame and net are as follows:

Beam:
- Iron pipe, length, 7 feet 6 inches.
- Outside diameter, $2\frac{1}{4}$ inches.
- Thickness of metal, $\frac{3}{16}$ inch.

Collars, brass, width, 2 inches; thickness, $\frac{1}{2}$ inch; length of flanges, 7 inches; diameter of bolts, $\frac{5}{8}$ inch.

Runners:
- Length, 4 feet.
- Height, 2 feet 3 inches + 3 inches; total, 2 feet 6 inches.
- Width, 2 inches.
- Thickness of metal, $\frac{5}{8}$ inch.

Weight of trawl frame, 140 pounds.
Rope for bridle, $2\frac{1}{2}$ inches.
Rope for lead rope, 2 inches.
Rope for head rope, $1\frac{1}{2}$ inches.

Trawl net:
- Length, 17 feet.
- Size of mesh, square, 1 inch.
- Material, cotton, barked, 21-thread.
- Pocket, length, 6 feet.
- Pocket, size of mesh, square, 1 inch.
- Pocket material, cotton, barked, 21-thread.
- Jacket, length, 6 feet.
- Jacket, size of mesh, square, $\frac{1}{2}$ inch.
- Jacket material, cotton, barked, 16-thread.

The method of attaching the beams to the runners is the same with both the deep-sea and beam trawl frames. Heavy brass collars are secured to the ends of the beams by screw threads, and to the runners by two bolts and nuts through each collar and runner, thus giving the frames the required rigidity. The parts can be assembled and dismounted in a few minutes; in fact, so readily that it has become a custom with us to dismount and stow the frames away whenever they are not required for immediate use.

THE DREDGE.

The dredge in ordinary use on shipboard, Plate XLIX, Fig. 1, is composed of two jaws or mouth pieces, flaring about 12 degrees, and joined together by an iron stud at each end, which is welded to the jaws. The net is laced through holes along the back of the mouth-pieces, and is protected from chafing on the bottom by a canvas shield drawn over it and laced through the same holes.

Short iron arms serve as a bridle, one being a few inches longer than the other and secured to it by a seizing, which is intended to part whenever undue strain is brought upon it and allow the dredge to be drawn up end on, in which position it would be most likely to free itself from an obstruction. The dredge used on board the Albatross is of the following dimensions:

Jaws:
- Length, 2 feet.
- Width, $2\frac{1}{4}$ inches.
- Opening between, 8 inches.
- Angle of, 12 degrees.

Stud:
- Length, 6 inches.
- Diameter, round iron, $\frac{3}{4}$ inch.

Bridle:
- Diameter, round iron, $\frac{3}{4}$ inch.
- Weight of metal part, 26 pounds.

Net:
- Length, 3 feet 6 inches.
- Size of mesh, square, 1 inch.
- Material, cotton, barked, 30-thread.
- Jacket, length, 2 feet 6 inches.
- Jacket, size of mesh, $\frac{1}{2}$ inch.
- Jacket material, cotton, barked, 16-thread.
- Bottom lining, cheese-cloth.

Shield, length, 3 feet 8 inches.
Shield, material, No. 2 cotton canvas.

The dredge described above, having its jaws set at an angle, is inclined to plow the bottom, and, where the latter is soft, bury itself beneath the surface. This is a necessary feature on a hard sandy bottom, but in the soft ooze of the deep sea it is a serious detriment. Various devises were resorted to by Lieutenant-Commander Sigsbee on board the Blake, and finally the following form was adopted and called the "Improved dredge." It is known here as the "Blake dredge," and will be referred to under that name, Plate XLIX, Figs. 3 and 4.

The following description is from Sigsbee's Deep-sea Sounding and Dredging:

"By reason of having flaring mouth pieces and a flexible body composed of the bag and shield, the old pattern dredge is almost sure to

plow deeply into yielding bottoms. Since the object sought in the fashioning of the new dredge was to effect a skimming of the bottom rather than a deep penetration therein, a very decided departure from the form of the old dredge was necessary. The frame of the new is a rectangular skeleton box made of wrought iron. The mouth pieces are flat, beveled on the forward inner edges, perforated along the rear edges, as on the old dredge, and riveted to the skeleton or bar-iron portions of the frame-work, in which position they are held parallel.

"The rear of the upper and lower sides of the skeleton are connected by three riveted braces, the whole frame-work being rigid. A tangle bar of heavy wood, bar-iron, or iron pipe, to carry the weights and tangles, has seized to it three sister hooks, which are hooked severally around the braces and moused. The arms are like those of the old dredge, one arm being longer than the other. A netting bag and canvas shield, as in the case of the old dredge, are stitched with pliable wire to the dredge frame. A trap like that of the trawl is fitted inside the main bag. The bottom of the main bag is stopped to the middle brace at the rear of the frame. Each flap of the canvas shield is turned over and around its own side and end of the skeleton frame, and stitched to its own part with stout twine, presenting a tolerably smooth sliding surface."

DIMENSIONS OF THE BLAKE DREDGE AS USED ON BOARD OF THIS VESSEL.

Jaws:
- Length, 4 feet.
- Width, 6 inches.
- Thickness of metal, $\frac{3}{8}$ inch.
- Distance of holes from edge, three-eighths of an inch.
- Distance between holes, 2 inches.
- Depth or opening between jaws, 9 inches.

Skeleton frame.:
- Length, including width of jaws, 4 feet.
- Diameter of round iron, one-half inch.
- Diameter of braces, three-fourths of an inch.

Long arm, length 4 feet.
Short arm, length 3 feet 9 inches.
Diameter of round iron, both arms, three-fourths of an inch.
Weight of dredge and frame, 81 pounds.
Shield, cotton canvas, No. 2.
Net:
- Length, 5 feet.
- Size of mesh, square, 1 inch.

Net material, cotton, barked, 30-thread.
Jacket:
- Length, 3 feet.
- Size of mesh, square, one-half inch.

Jacket material, cotton, barked, 16-thread.
Bottom lining, cheese-cloth.

THE CHESTER RAKE DREDGE.

Plate XLIX, Fig. 2, shows the Chester rake dredge designed for the purpose of obtaining mollusca, annelids, crustacea, &c., which burrow beneath the surface out of reach of any other apparatus in use by the United States Fish Commission.

The rake is shackled to the dredge rope, and a Blake dredge, secured to eyebolts on the rear of each end of the frame, following it as it is dragged over the bottom, picking up whatever is turned over by its strong harrow-like teeth.

DIMENSIONS OF THE CHESTER RAKE.

Frame:
- Length, 3 feet.
- Depth of opening, 10 inches.
- Width of metal, 2½ inches.
- Thickness of metal, one-half inch.

Teeth:
- Length, 7 inches.
- Width of base, pointed, 2½ inches.
- Thickness of metal, base, one-half inch.

Arms:
- Length of long arm, 3 feet 5 inches.
- Length of short arm, 3 feet 3 inches.
- Diameter, round iron, three-fourths of an inch.

Weight, 79 pounds.

This admirable instrument was devised by Capt. H. C. Chester, to whom the Commission is indebted for many practical suggestions as well as for some of its most valuable apparatus.

BOAT DREDGE.

The boat dredge is essentially a miniature form of the ordinary ship's dredge already described, and is designed for use from boats where it must be worked by hand.

DIMENSIONS OF THE BOAT DREDGE.

Jaws:
- Length, 1 foot 7 inches.
- Width, 2½ inches.
- Opening, 7½ inches.
- Angle, 12 degrees.

Stud:
- Length, 6½ inches.
- Diameter, round iron, five eighths of an inch.

Bridle:
- Diameter, round iron, one-half inch.
- Length, 1 foot 5 inches.

Weight, 15 pounds.

Net:
- Length, 1 foot 8 inches.
- Size of mesh, square, three-sixteenths of an inch.
- Material, cotton, 3-thread, bottom double.

Shield:
- Length, 2 feet 8 inches,
- Material, No. 3 cotton canvas,

TRAWL WEIGHTS.

It is customary with us to attach one or more trawl weights to the tail of the trawl net, and, in shoal water, one to each runner. Two or three are also used with the dredge and tangles.

DIMENSIONS.

Length, 11 inches.
Diameter of base, square, 4 inches.
Diameter 8½ inches above base, 3 inches.
Size of hole, 1 inch by 1¾ inches.
Thickness of metal around hole, three-fourths of an inch.
Material, cast iron.
Weight, 27 pounds.

THE TANGLE BAR (PLATE L).

The form of tangle bar used was devised by Prof. A. E. Verrill in 1873, and consists of an iron bar supported at each end by a fixed wheel, or iron hoop. Six chains about 12 feet in length are attached to the bar at intervals of 1 foot. To these chains are secured deck swabs, or bundles of rope yarns, at intervals of about 18 inches.

It is very useful on rocky bottoms where it will capture specimens when no other device could be made available.

DIMENSIONS.

Wheels:
- Diameter, 1 foot 2 inches.
- Width, 2½ inches.
- Thickness of iron, one-half inch.
- Width of cross-bars, 2½ inches.
- Thickness of cross-bars, three-fourths of an inch.

Chain bar:
- Length, 6 feet.
- Width, 2½ inches.
- Thickness, 1 inch.
- Rings for drag rope, diameter, 4 inches.
- Rings for drag rope, diameter of iron, five-eighths of an inch.

Tangle chains:
- Diameter of iron, three-eighths of an inch.
- Length, 12 feet.

Tangles, hemp, length, 3 feet.

THE TANGLES.

The tangles, Plate LI, were devised by the writer in 1884 as an improvement on the tangle bar, being less liable to foul on the rough rocky bottoms where it is generally used.

NOMENCLATURE.

a. Bow.
b. Tangle bars.
c. Tangles.
d. Eyebolts.
e. Bolts and nuts.

f. Arm.
g. Eyebolt.
h. Sinker.
i. Dredge rope.
j. Dredging block.
k. Dredging boom.

DIMENSIONS.

Bow (steel):
 Diameter, 11 inches.
 Width at center, 3 inches.
 Width at ends, 2½ inches.
 Thickness at ends, one-half inch.
 Thickness at center, one-fourth of an inch.
Tangle bars (iron): .
 Length, 5 feet.
 Width, 2½ inches.
 Thickness, one-half inch.
 Number of holes for tangles, 5.
 Diameter of holes, five-eighths of an inch.
Eyebolts for tangles (iron), diameter, one-fourth of an inch.
Tangles (hemp), length, 4 feet.
Tangles (beckets), 21-thread ratlin stuff.
Arm (mild steel):
 Semi-circular, diameter, 1 foot 6 inches.
 Width of metal, 2½ inches.
 Thickness of metal, one-half inch.
Eyebolt (iron), diameter of metal (square), five-eighths of an inch.
Sinker (cast-iron):
 Diameter, 9 inches.
 Weight, 150 pounds.

The first tangle of this form was improvised at sea, after expending the last tangle bar, by bending a bar of iron in the form of a V, the tangles being seized to a 3-inch rope, which was drawn around the frame and secured to it by lashings. It worked so well that we used it the remainder of the cruise and finally adopted the present form.

The bow *a* is made of spring-tempered steel and permits the bars to close with a pressure of between 300 and 400 pounds applied to their extremities, so that the apparatus will pass between rocks or other obstructions which permit the passage of the bow and sinker.

Each tangle is secured to its bar by a one-fourth inch eyebolt, which draws at a tension of about 1,000 pounds, releasing its tangle when irretrievably fouled on the bottom without endangering the loss of the whole apparatus. The tangle bars were made separately from the bow and attached by bolts and nuts at *e* to secure better stowage and make the parts lighter to handle. The semicircular arm *f* is intended to raise the forward end of the tangle frame a few inches off the bottom; also to act as a shoe in dragging over rocks or other uneven surfaces. It is held in position by the eyebolt *g*, which is square and fits snugly in square holes in the arm and bow.

The tangles are, in material, size, and structure, practically the same as the deck swabs in general use on board ship.

THE TABLE SIEVE.

The table sieve in its present form, Plate LII, Fig. 2, is an outgrowth of the cradle sieve, Plate LII, Fig. 1, which was formerly used in washing the contents of the dredge, the more bulky loads of the trawl having been emptied on deck.

The first table sieve was devised by Capt. H. C. Chester and Prof. A. E. Verrill, and consisted of a rectangular table supporting a fine sieve, and over it the hopper with its coarse wire netting.

The canvas bottom and chute were added by Mate James A. Smith, U. S. N., executive officer of the U. S. S. Speedwell, while in the employ of the United States Fish Commission, about 1877.

To prepare the table sieve for use, place the sieve *c* in the frame *a* on cleats provided for it a few inches above the canvas bottom *d;* then place the hopper in the frame over the sieve and carry the chute *e* to a scupper.

DIMENSIONS.

Table frame:
- Length, 5 feet 6 inches.
- Breadth, 3 feet 2 inches.
- Depth, 1 foot.
- Height from deck to top of frame, 3 feet 2 inches.
- Thickness of planks, 1 inch.

Hopper:
- Length, top, 5 feet 9 inches.
- Length, bottom, 4 feet.
- Width, top, 3 feet 5 inches.
- Width, bottom, 2 feet 6 inches.
- Depth, 1 foot 1 inch.
- Thickness of planks, 1 inch.
- Size of mesh, galvanized-iron wire netting, five-eighths of an inch.

Sieve:
- Length of frame, 5 feet 3 inches.
- Breadth, 2 feet 11½ inches.
- Depth, 2½ inches.
- Thickness of planks, 1½ inches.
- Size of mesh, galvanized-iron wire netting, one-twelfth of an inch.

Bottom, No. 4 cotton canvas.

The table legs are now made detachable, which materially reduces the space required for stowage.

THE CRADLE SIEVE.

This sieve was devised by Prof. A. E. Verrill in the early days of the United States Fish Commission, for the purpose of rapidly washing out the mud brought up by the dredge. It has wooden ends nearly semicircular in form, joined by narrow strips which are let into the end pieces so as to present a smooth surface. A fine netting is drawn over the surface, and supported by an outer netting of coarse mesh secured firmly to the ends and side pieces. An inner sieve with coarse mesh

rests on and partially inside of the main sieve. It is intended to be hung over the vessel's side by means of a rope bridle attached to iron straps on the end pieces.

In use it has been superseded by the table sieve.

DIMENSIONS OF CRADLE SIEVE.

Length, 3 feet.
Breadth, 1 foot 6 inches.
Depth, 1 foot.
Width of side pieces, $3\frac{1}{2}$ inches.
Thickness of side pieces and ends, 1 inch.
Depth of inner sieve, 8 inches.

THE STRAINER.

The strainer, Plate LII, Fig. 3, was introduced by Mr. James E. Benedict, resident naturalist of the Albatross, for the purpose of passing all water used for washing the mud out of the table sieve through strainers fine enough to retain minute annelids, foraminifera, &c., which would otherwise be lost.

Its construction is very simple. An oil barrel was cut down until it would slide under the table sieve. Three iron drain-pipes are inserted in the side, one diagonally over the other, and attached to them are three strainers, *a*, *b*, and *c*, Fig. 3, made of linen scrim, through which the water is drained as it rises successively to the level of each. The combined areas of the three are sufficient to carry off the water supplied by the steam hose under ordinary circumstances. When it is to be used in connection with the table sieve the long chute *e* is removed, and a short one about a foot in length substituted, the water being discharged directly into the strainer.

DREDGING QUADRANT.

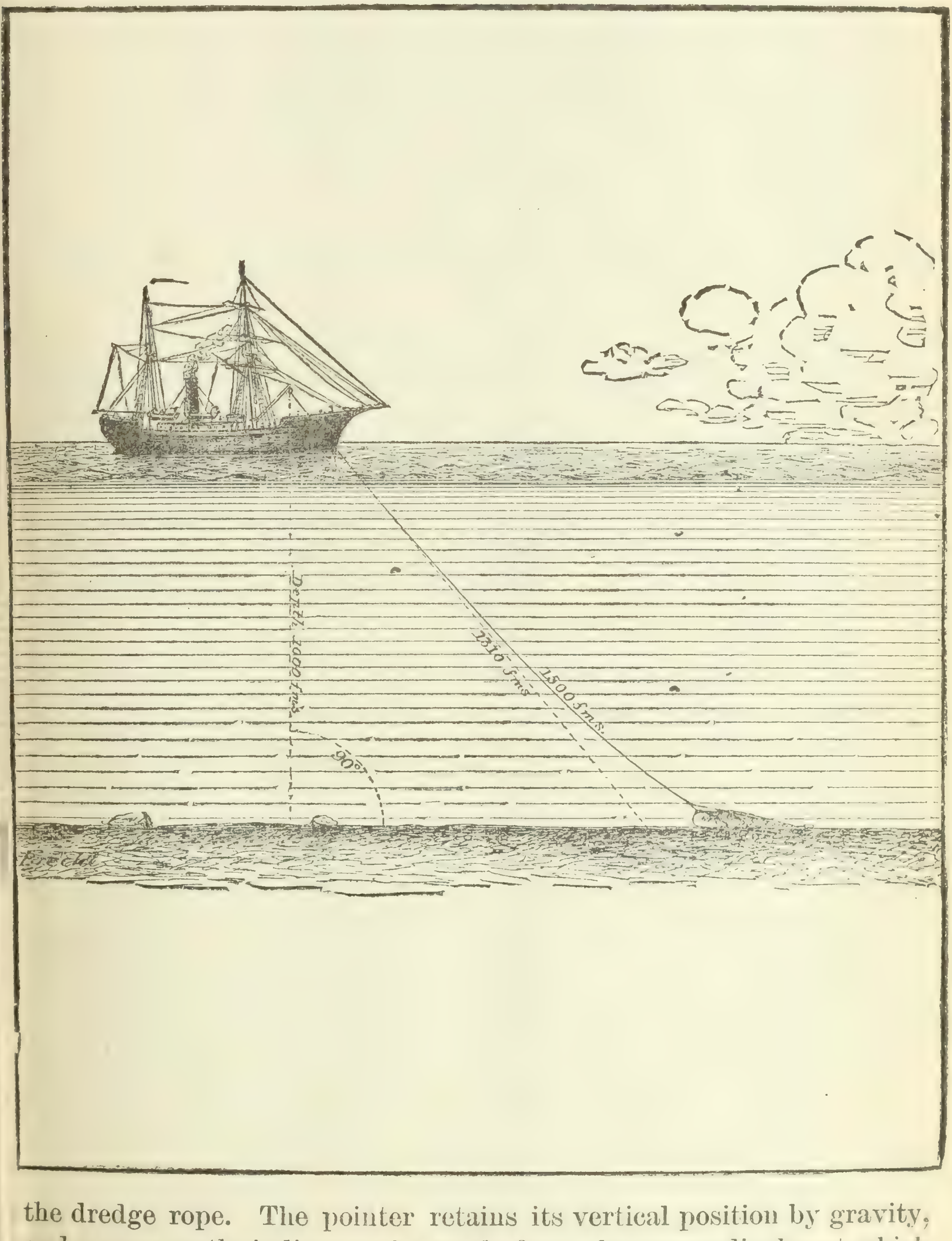
The dredging quadrant, Plate XXVIII, was devised by the writer for the purpose of ascertaining approximately the position of the trawl when working in deep water by observing the angle of the dredge rope. The instrument was improvised while working in over 2,500 fathoms in the Gulf Stream, where the necessity for a guide of some sort was seriously felt.

It is made of black walnut, 2 feet in length and three-quarters of an inch in thickness; the arms are 2 inches in width and the graduated semicircle or double quadrant is 8 inches in diameter. The graduation is on the periphery from 0, when the instrument is held vertically, to 90 degrees to the right and left. The pointer is made of lead one-sixteenth inch in thickness, and swings freely on its pivot.

The figures were stamped with ordinary dies and the depressions filled with white lead. The original instrument is still in use, it having answered the purpose so well that we have had no disposition to replace it.

THE ANGLE AND SCOPE OF DREDGE ROPE.

Its use will be readily understood by reference to the above cut where the vessel is backing and the rope trending ahead. The officer in charge, taking the quadrant in both hands and placing himself in proper position, glances along its straight-edge, inclining it until it is parallel with



the dredge rope. The pointer retains its vertical position by gravity, and consequently indicates the angle from the perpendicular at which the instrument is held or the angle of the dredge rope, which, in this case, is 40 degrees. Enter Table 11, Bowditch, with this angle as a

course, and find the depth, 1,000 fathoms, in the difference of latitude column (taking one-tenth of the amount), 100.4 being the nearest number. Opposite to this, in the distance column, is 131, which being multiplied by 10 gives 1,310 fathoms, the hypotenuse of the right triangle we have constructed. As the rope has a catenary curve it is necessary to make an allowance in order to insure the trawl reaching and remaining on the bottom. Experience has taught us that about 200 fathoms is sufficient with the above depth and angle; therefore, with a scope of 1,500 fathoms, and the angle of the rope maintained between the limits of 35 degrees and 40 degrees, a successful haul may be anticipated as far as the landing and dragging of the trawl on the bottom is concerned. The speed can be easily regulated, after a little practice, so as to confine the rope between the above limits.

The quadrant is made double in order that it may be used on either side of the vessel, whether steaming ahead or backing.

SIGSBEE'S GRAVITATING TRAP (PLATES LIII, LIV, AND LV).

The tow net was among the first apparatus used by naturalists to obtain minute animal forms from the surface of the sea, and the same apparatus has been used for collecting at intermediate depths, various methods being employed for sinking it. The range was confined within narrow limits, generally not exceeding a few fathoms below the surface, and even then it was not altogether satisfactory, as specimens might be taken while sinking the net, or hauling it up, their habitat still remaining a mystery.

The dredge rope was brought into requisition on the Challenger, the tow net being secured at the point required to sink it to the desired depth, but the same cause for doubt still existed as to the locality in which specimens were caught in the open-mouthed net, which was twice dragged through the intervening space between the surface and the working depth. The same practice was followed on board of the Fish Hawk until we improved upon it by adopting the wing nets, which were secured to the ends of the trawl beam and acted as collectors from the surface to the bottom, along the bottom as far as the trawl was dragged, and again from the bottom to the surface. There was no pretense of locating the habitat of the myriads of specimens taken in this manner, the nets being used for the simple purpose of making the capture.

The specimens procured by any of the methods above mentioned cannot be assigned to determinate depths. Feeling the need of some device by which this desirable end could be obtained, Prof. Alexander Agassiz, in 1880, requested Lieut.-Commander C. D. Sigsbee, U. S. N., to co-operate with him in devising the necessary apparatus.

Sigsbee says, with reference to the matter (Bulletin of the Museum of Comparative Zoology, Cambridge, vol. vi, pp. 155–6):

"It occurred to me that by using an apparatus in connection with a line and lead, paid out vertically as in sounding, and by dragging ver-

tically instead of horizontally, as formerly, there would be as much certainty with regard to depths as in the old method, and that simple mechanical devices could be invented to satisfy the conditions of the work. The scheme has been stated in my volume on Deep-sea Sounding and Dredging (p. 145, foot-note) as follows:

"'Our plan is to trap the specimens by giving to a cylinder, covered with gauze at the upper end and having a flat valve at the lower end, a rapid vertical descent between any two depths as may be desired, the valve during such descent to keep open, but to remain closed during the process of lowering and hauling back with the rope. An idea of what it is intended to effect may be stated briefly thus: Specimens are to be obtained between the intermediate depths *a* and *b*, the former being the uppermost. With the apparatus in position, there is at *a* the cylinder suspended from a friction clamp in such a way that the weight of the cylinder and its frame keeps the valve closed; at *b*, there is a friction buffer.

"'Everything being ready, a small weight or messenger is sent down, which on striking the clamp disengages the latter and also the cylinder, when messenger, clamp, and cylinder descend by their own weight to *b*, with the valve open during the passage. When the cylinder frame strikes the buffer at *b*, the valve is therefore closed, and it is kept closed thereafter by the weight of the messenger, clamp, and cylinder. The friction buffer, which is 4 inches long, may be regulated on board to give as many feet of cushioning as desired.'"

The following is a detailed description of the apparatus:

NOMENCLATURE.

A. Cylinder, copper.
B. Frame, wrought iron.
C. Flap or clapper valve.
D D. Levers.
E. Pivot.
F. Wire sieve (60 wires to the inch).
G. Wire sieve (27 wires to the inch).
H. Wire funnel or trap (27 wires to the inch).
I I. Loops on fairleaders.
J J. Rollers.
K. Frame of friction clamp.
L. Sliding chock.
M. Sliding chock.
N. Adjusting screw.
O. Sling.
P. Eccentric tumbler.
Q. Frame of friction buffer.
R. Sliding chock.
S. Sliding chock.
T. Adjusting screw.
U. Compression spring.
V. Regulating screw.
W. Key.
X. Messenger, cast-iron.

Plate LIII shows the apparatus properly adjusted on the steel-wire dredge rope ready for use. The cylinder A is suspended to the friction clamp by the tumbler P, and confined to the dredge rope by means of the fairleaders I I. The friction buffer is clamped to the rope beneath the cylinder, and the messenger is shown above the apparatus in the act of descending.

Plate LIV shows a detailed plan of the cylinder as follows: Fig. 1, a vertical sectional elevation; Fig. 2, a side view; Fig. 3, a top view; and Fig. 4, a bottom view. The copper cylinder A is secured to the wrought-iron frame B by brass screws, and at the bottom of the frame there is a flap or clapper valve C, which is pivoted at E and opened inwards. It is actuated by the levers D D. The wire sieve F is clamped to the top of the cylinder A; the sieve G is inside of the cylinder A, and is supported on the top of the frame or trap H; the latter being supported on a brass ring secured to the inner surface of the cylinder A, and is held in place by brass clamps. Both the sieve G and the trap H are readily removed.

The steel-wire dredge rope on which the cylinder travels is seen in the fairleaders I I, where it is held in place by the rollers J J.

Fig. 1 of Plate LV is a side view of the friction buffer; Fig. 2 is a sectional elevation; Fig. 3 is a top view; and Fig. 4 is also a top view with the steel face-plate removed.

The frame A of the buffer is made of brass; the sliding chocks R and S, adjusting screw T, compression spring U, and regulating screw V are of steel. The sliding chocks work in the apertures in the frame as shown in Figs. 2, 3, and 4. Their bearing surfaces are corrugated and their inward movement is limited by studs which are part of the frame and fit loosely within a slot in the chocks.

* "In clamping the buffer to the rope the chock R is always screwed in until stopped by its stud; the steel rope is therefore always pressed between the two chocks by the elastic force of the spring, which may be regulated as desired. To regulate the buffer for any definite frictional resistance, clamp it to the rope, and move the regulating screw V well inward; then suspend from the buffer a weight equal to the resistance decided upon. Move the regulating screw outwards until the buffer slides down the rope under the influence of the suspended weight.

"Since the chock R is always screwed down in clamping the rope, the buffer remains regulated for prolonged use with the same resistance; and if the latter proves satisfactory it is probable that the regulating screw need not be touched again for a whole cruise, if the buffer is rinsed in lye-water each time after use."

Fig. 5 is a top view of the friction clamp, and Fig. 6 a side view. The frame K is of brass; the sliding chocks L and M, adjusting screw N, and eccentric tumbler P are made of steel.

Fig. 7 is a side view of the messenger X, Fig. 8 a sectional elevation

* Sigsbee.

and Fig. 9 a cross-section. The messenger is made of cast iron in two parts, which are held in position on the rope by lashings passed in the scores prepared for the purpose. The key is shown in Fig. 10.

WORKING THE APPARATUS.

* "It is necessary first to regulate the buffer to cushion the stoppage of the falling weights, which are, cylinder and frame, 38 pounds, clamp 4 pounds, messenger 8 pounds, total 50 pounds. The Blake adopted a resistance of about 80 pounds (this resistance being of course constant during the whole movement of the buffer), it having been found that a blow of that force resulted in no injury to the apparatus.

"On the ascent the buffer must withstand not only the weight of the 50 pounds of metal, but also the resistance which the water offers to the passage through it of the several parts of the apparatus. Moreover, when the cylinder emerges from the water it is full of that liquid and with this increased weight would overcome the stated resistance of the buffer and force the latter downwards until the lead was reached. To meet these conditions it was not thought advisable to increase the resistance of the buffer, which would involve a heavier blow against the apparatus, but a rope-yarn seizing or stop was placed on the rope about 15 or 20 feet below the buffer, beyond which the latter could not pass.

"Having secured the buffer to the rope about 5 or 6 fathoms above the lead (a very heavy lead to keep the rope straight) and paid out the length of rope required to span the stratum to be explored by the cylinder, the clamp and cylinder are attached, the latter being suspended from the former as follows:

"The rope having been placed between the two sliding chocks of the clamp, the arm of the eccentric tumbler is thrown up, which moves the chock M inwards; then, by means of the adjusting screw, the chock L is pressed against the rope, securing the clamp in position. The cylinder hangs 4 or 5 inches below the clamp and is supported by a loop of soft wire which rests on the lip of the tumbler; the ends of the wire, being run through holes in the upper part of the frame of the cylinder, are fastened permanently to the outer arms of the lever D, to which the valve is screwed. It is seen that by this method of suspension the weight of the cylinder and its frame is used to keep the valve closed while paying out. The cylinder should be filled with water, poured down through the upper sieve, to maintain the valve on its seat while the cylinder is being immersed. Rope is then paid out slowly until the cylinder is at the desired depth, when the rope is stoppered and the messenger sent down. The messenger strikes the arm of the eccentric tumbler, throwing it down and tripping the cylinder. The tumbler in falling relieves the pressure on the sliding chock M, which is then free to recede from the rope.

"Messenger, clamp, and cylinder fall together, the valve being held

* Sigsbee.

open by the resistance of the water. A current is established through the cylinder, and specimens which enter are retained by the upper sieve. When the buffer is reached, the valve is closed by the pressure against the outer arms of the lever.

"A very slight pressure on the adjusting screw of the clamp, after the chocks are bearing against the rope, is enough to prevent the clamp from slipping, but by an increased pressure on the screw a greater force is required to trip the tumbler, and by this feature the arm of the tumbler is utilized to break the force of the blow which the body of the clamp receives from the falling messenger.

"A few rings of sheet-lead may be laid on the top of the clamp and buffer respectively."

E.—GENERAL DESCRIPTION OF THE METHOD OF SOUNDING, TAKING SERIAL TEMPERATURES, SPECIFIC GRAVITIES, AND A HAUL OF THE TRAWL.

Having explained the apparatus in use on board the Albatross for deep-sea exploration, a general description of the operations at a single station will be given. We will suppose the depth to be about 1,000 fathoms, scope of dredge rope 1,500 fathoms, wind and sea moderate.

If the working reel is still in its tank it should be suspended and allowed to drain at least a half-hour before being mounted on the machine. We suspend it in its own tank by laying two strips of wood across the top and resting the axle on them, the lower part of the reel being an inch or two above the surface of the oil.

The officer of the deck warns the engineer of the watch half an hour before a station is to be occupied in order that the fires may be regulated. He then makes the necessary preparations on deck; has the reel mounted and the Sigsbee sounding machine rigged for use, the trawl mounted, bridle stops put on, wing nets adjusted, trawl net lashed (the ends of the bridle being made fast by the same lashing), and the mud bag secured to the eyes in the end of the bridle. If the trawl is dry a 27-pound weight is usually included with the mud bag. He has the dredging blocks overhauled and oiled, the register for the dredge rope adjusted, the hoisting and reeling engines oiled and prepared for use, the topping-lift shackled to the dredging boom, and the guys hooked. The end of the dredge rope which is on the drum of the reeling engine on the berth deck, Plate XXIV, is rove through the guide, thence forward through the leading-block, Plate II, Fig. 4, and under the governor pulley, 108, to the large winch-head of the hoisting engine on the upper deck, 40. Five turns of the rope are then taken around the winch-head, and the end carried aloft and rove through the accumulator block, Plate XLII, thence under the register pulley in the heel of the boom and through the dredging-block at the boom end. A thimble is then spliced in and the rope shackled to the trawl.

The boom is then topped up to an angle of about 50°.

When the vessel reaches the intended station the officer of the deck stops her with her stern to the wind, has the patent log hauled in, and then takes his station on the grating at the sounding machine, where he superintends the sounding, and maneuvers the vessel to keep the wire vertical during the descent. Having satisfied himself that the specimen cup is properly bent to the stray line, the sinker adjusted, the thermometer and water bottle clamped, the friction rope properly attended by a careful man detailed for the purpose, a man forward of the machine at the brake, one abaft it with the crank shipped, and another on the grating to attend the guide pulley, he will lower away gently until the apparatus is under water, then seize the small lead to the stray line, caution the record keeper to look out, have the pawl thrown back and the crank unshipped, and order "Lower away!" The speed of descent is regulated by him, and the record keeper reports and records the time at every 100 fathoms, the average being about 1^m 8^s with a 30-pound sinker, which would be used in the depth mentioned above.

The navigator determines the position. As soon as the sinker reaches bottom the reel is stopped by the friction rope, the record keeper notes the number of turns indicated by the register, the men stationed at the right and left of the machine ship the cranks and heave in a few turns to clear the specimen cup from the bottom, then throw the pawl into action, unship the cranks, unreeve the friction rope, and throw the belt on and set it up by means of the tightening pulley and belt tightener. A fireman, or machinist, has in the meantime prepared the reeling engine and shipped the ratchet crank on the crank shaft. When all is ready, and after the thermometer has had time to record the bottom temperature, the throttle is opened gradually, the engine being assisted over the centers with the ratchet crank, until a uniform speed is attained. The wire is reeled in at the rate of 100 to 125 fathoms per minute, each 100 fathoms being reported and the time noted by the record keeper.

When the stray line appears above water the engine is stopped, the cranks shipped, and the remaining few fathoms reeled in carefully by hand, stopping first to take off the small lead, then the water bottle, which is unclamped by the officer and handed to the man at the guide pulley to be delivered to the medical officer, who either takes its specific gravity or carefully seals it in a bottle prepared for the purpose to be forwarded to the laboratory at Washington for analysis.

The officer then unclamps the thermometer, reads the temperature, which is verified by the record keeper, who resets the instrument and sends it to the pilot-house, where it is suspended from a hook provided for the purpose.

The specimen cup is next removed from the end of the stray line and sent to the laboratory, where its contents are examined by a naturalist who informs the record keeper of the character of the bottom to be entered in his book. The officer of the deck makes this examination himself at times when the naturalists are otherwise engaged.

As soon as the specimen of ocean soil is removed the cup is carefully rinsed in water and adjusted for use.

A small portion of each bottom specimen is preserved in a vial whenever we are working on new ground, or if anything unusual is discovered, and at the end of each season the specimens thus collected are sent to the laboratory at Washington.

SERIAL TEMPERATURES AND SPECIFIC GRAVITIES.

As soon as the wire is in, the wind is brought a trifle on the starboard quarter by stopping the port engine and backing slowly on the starboard, turning ahead on the port if necessary.

There are two cast-iron sinkers provided for the temperature rope, one 520 and the other 150 pounds weight. One of these is shackled to the end of the dredge rope, swung over the side, and lowered a fathom or two under water, to steady it, the boom being rigged in until the rope rests against the side, inclining a little inboard above the rail.

The vessel having been placed in position, a thermometer and water bottle are sent to the officer of the deck, who clamps them to the temperature rope, the former lower down, in order that, in capsizing to register the temperature, there will be no danger of its striking the water bottle. The navigator sets the valves of the water bottles, and examines the thermometers before they are sent out.

The dredging boom is swung out far enough to clear the rope from the ship's side, and 100 fathoms veered, another thermometer and water bottle clamped on, and the operation repeated to 800 fathoms; the next and last 100 fathoms has instruments at 50 and 25 fathoms.

When sufficient time has elapsed for the thermometer at 25 fathoms to take the temperature the rope is reeled in and the boom swung in as the instruments appear above the rail. The officer of the deck unclamps the thermometer and reads it, then hands it to the record keeper who verifies the reading and notes it, as well as the number of the instrument, in the record book. The boatswain's mate of the watch unclamps the water bottle and delivers it to the surgeon or apothecary, who disposes of it as before mentioned. The instruments are rinsed in fresh water and returned at once to their proper receptacle.

The process is repeated as each pair of instruments reaches the surface until they are all on board, when the sinker is removed and the trawl shackled to the dredge rope. The rate at which the instruments are lowered and hoisted is from 50 to 75 fathoms per minute, depending somewhat upon the state of the sea.

It may not be out of place to mention here the care with which the temperatures are read when the deep-sea thermometers are used. It is well known that an error of parallax arising from the thickness of the thermometer tube is liable to occur; and, in order to reduce it to the minimum, the writer devised a sight block, which is simply a piece of close-grained wood an inch and a half in length, an inch wide, and

three fourths of an inch thick. A score is cut on one end which conforms in shape to the outside of the metal case inclosing the thermometer. To read the thermometer (Negretti and Zambra's) hold it at the height of the eye and toward the strongest light. Place the score of the sight block against the metal case, below the point of reading, and raise it carefully until the line of sight corresponds exactly with the upper surface of the block and the top of the column of mercury in the tube, when the temperature may be read with much greater accuracy than could be attained without the block.

DREDGING OR TRAWLING.

As soon as the sinker is on board, the port engine is started with a caution to the engineer of the watch to "Go slow for dredging!"

The vessel will naturally swing to starboard, which she is allowed to do until the intended course is reached, the wind on the starboard bow, or abeam, being the most favorable if it is intended to steam ahead while dredging.

In the meantime the trawl has been hoisted to the boom end and swung out ready for lowering as soon as the vessel is steadied on her course. It is first landed on the surface of the water and held there until the frame assumes a horizontal position, the net extending aft, at full length, the mud bag floating clear of the bridle ends, and the wing nets towing aft and clear. Then the order is given, "Lower away!" The speed of lowering is regulated by the record keeper, who stands, watch in hand, ready to check or increase the rate of descent, which is never allowed to exceed 25 fathoms per minute in depths over 300 fathoms. The machinist attending the hoisting engine calls out each 100 fathoms, so that the officer in charge knows at all times the amount of rope out.

The port swinging boom is rigged out and towing nets put over as soon as the vessel is steadied on her course, the speed for dredging (about 2 knots per hour) being admirably adapted for surface work. The nets are in charge of a man detailed from the crew, who works under the direction of a naturalist.

While the trawl is being lowered the officer in charge watches the angle of the rope, regulating the speed to keep it between 30° and 60°. He notes the trend of the rope also, whether it is toward or from the ship, and in the former case changes the course a trifle to starboard, which tends to carry it from the side. It frequently happens that the vessel will not steer with the port engine turning at a speed of 2 knots or less, especially after much rope has been veered out. In this case the starboard engine is started and the port one stopped. There is no difficulty while the starboard engine is in motion, as the inclination to turn to port is counteracted in a great measure by the drag of the trawl. This engine would be used at all times when steaming ahead were it

not for the danger of the trawl or dredge rope fouling the propeller before they sink below the surface.

The angle of the rope will gradually decrease as the trawl descends, and if it is 60° at starting it should be about 40° when the limit of 1,500 fathoms is reached. Should it exceed that angle after the engine has been running "dead slow," as may happen with a current in the direction of the course, it is advisable to stop until the angle is between 30° and 35°, then move ahead slowly with the same engine, regulating the speed so as to keep the angle between 35° and 40°. If there is no current the requisite speed will be readily attained with the engine; but if there should be a current with the wind, and the lowest speed attainable be too great, the engine should be stopped and the vessel allowed to drift, the rate being increased, if desirable, by the use of sail. In exceptional cases we have found it necessary to retard the drift by backing one of the engines.

The accumulator is watched closely after the trawl is landed, and any increase in weight is carefully noted. Should the increase be gradual and not excessive, the trawl is undoubtedly performing its functions normally; but a sudden addition of 2,000 or 3,000 pounds indicates that the trawl has either encountered some obstacle or buried itself in the soft ooze of the ocean bed. In either case instant relief is required and is received, first, from the hoisting engine, which, having its friction lever properly set, allows the dredge rope to run out when the limit of safety is reached; then the engine is stopped and reversed, and, as as soon as the headway is checked, preparations are made for heaving in.

The vessel is then backed slowly toward the trawl, the slack rope reeled in, keeping a tension on it equal to or somewhat greater than the weight of rope out, in order to guard against slack which would result in kinks. In this manner the vessel will be placed directly over the trawl and the rope hove short. If the trouble has arisen from an ordinary obstruction it can be cleared usually by backing in the opposite direction from which it was laid out. Should this maneuver fail it is pretty safe to conclude that the trawl has buried, and in this case we heave in until we reach the limit of safety and allow the vessel to ride by the rope until the tension decreases; then heave again, until the trawl is gradually worked out of its bed. We then steam ahead slowly, washing the mud from the net until it can be hove up safely.

Should all efforts fail to clear it, as sometimes happens, we make everything fast and steam ahead until either the bridle-stops part and the trawl comes up tail first, or the rope parts, the trawl and its attachments being lost.

The most trying position is when we get an overload of stones, clay, or tenacious mud which will not wash through the meshes of the net, and must be hove up with the greatest care, consuming hours of valuable time, and not infrequently parting the bridle stops or the rope just

as the trawl heaves in sight, losing the entire contents or the trawl itself, as the case may be.

Supposing everything to have worked satisfactorily and the trawl been dragging half an hour, the order is given to get ready for heaving. The hoisting engine is moved to work the water out of the cylinders, and the moving parts are oiled. The reeling engine is likewise put in readiness, the guide connected, and the governor brought into action. Everything being ready the order is given to heave away, and the rope reeled in at the rate of 25 fathoms per minute, the vessel being allowed to retain her headway until the trawl is known to be well clear of the bottom.

This is done for the double purpose of avoiding the danger of the trawl settling in the mud if allowed to remain stationary for any length of time, and to prevent fish or other specimens which have not already found their way to the pocket from floating or swimming out of the mouth of the trawl.

The speed at which it is hove up is varied according to circumstances, not exceeding 30 fathoms per minute under the most favorable conditions when the specimens are from a greater depth than 500 fathoms; although in shoal water a speed of 35 fathoms per minute is at times admissible. The machinist at the hoisting engine reports each 100 fathoms as in veering out, and the record keeper notes it in his book.

After the trawl is off the bottom and the engine stopped, the dredge rope will sometimes draw under the bottom, even though the vessel has her starboard broadside to the wind and is drifting rapidly. In this case we would back the starboard engine, go ahead on the port, and put the helm hard a-port, which would soon clear it. This trouble usually occurs in reeling in after the trawl has been laid out, steaming head to wind or backing stern to it, and the vessel has been allowed to fall off with the dredge rope to windward, a position which at first sight seems to be the proper one. Such is not the case, however, for the vessel is lying at right angles to her former course, and consequently with the rope trending under her bottom. If it is reeled in faster than the vessel is drifting, it will be drawn still more closely under the keel.

If the trawl has been laid out against the wind, heave to with the dredge rope to leeward, when the drift will assist the operation of reeling in. It should be borne in mind, however, that the vessel must be turned with the dredge rope to windward by backing the starboard and going ahead on the port engine before it draws under the bottom, which it will do as soon as the vessel has drifted over the position of the trawl.

When the trawl is up, the boom is rigged in until the bag swings against the ship's side, when a strap is passed around it and it is hoisted on board by means of a stay tackle. If the load is very heavy, the afterboom guy is used to help to get it over the rail, the lower block being hooked usually to the eye in the end of the bridle.

The mud bag is removed first, then the lashings taken off, and the

contents emptied into the table sieve. The naturalists then collect the specimens, the steam hose being used to wash the mud from them.

The trawl is lowered on deck after being relieved of its contents, the wing nets and trawl nets carefully attended to, the lashings replaced, bridle-stops examined or renewed, and everything made ready for another haul.

The vessel resumes her course as soon as the trawl leaves the water.

The handling of the trawl and the maneuvering vessel while trawling is under the personal supervision of the commander or executive officer.

The time consumed in sounding, taking serial temperatures, and a haul of the trawl as described is about three and one-half hours.

F.—OTHER APPARATUS.

The fishing gear, collecting apparatus, and laboratory outfit are quite extensive. The following summary includes the most important articles:

FISH LINES RIGGED FOR USE.

12 squid lines.
10 whiting lines.
2 boat-cod hand-lines, 2-pound leads.
2 boat-cod hand-lines, 3-pound leads.
2 boat-cod hand-lines, 4-pound leads.
5 red snapper lines.
5 bluefish lines for trolling.
4 sea-bass lines, style used in Southern States.
4 sea-bass lines, style used by New York smackmen.
5 bluefish lines for still-baiting.
1 shark line.
8 skates halibut trawl line.
4 tubs haddock trawl line.
60 mackerel hand-lines.

In addition to the lines ready for use, the laboratory contains a quantity of spare lines and a large assortment of hooks, sinkers, jigs, &c.

MISCELLANEOUS APPARATUS USED IN FISHING.

Anchors, snug stow net.
Anchors, snug stow trawl.
Baskets.
Buoys, halibut trawl.
Buoys, keg net.
Compasses, dory.
Fish forks.
Fish pew.
Floats, covered glass.
Gaffs, deck, cod.
Gaffs, dory, cod.
Gaffs, iron, halibut.
Harpoons, assorted.
Hooks, ice.
Hurdy-gurdy or trawl winch.
Jigs, mackerel.
Jigs, squid.
Knives, codfish bait.
Knives, codfish throating.
Knives, dory.
Knives, halibut bait.
Knives, mackerel splitting.
Knives, oyster.
Lance, shark-killer.
Lance, whale.
Leads for net lead-line.

Mill for grinding bait.
Mold for lead-line sinkers.
Mold for mackerel jigs.
Nippers, woolen.
Scoops, bait.
Scoops, ice.
Splicers, iron line.
Swivels, snood.
Swivels, slot.
Shovel, ice.
Sling ding spreaders.
Tubs, dressing.
Tubs, gib.
Whale gun.
Whale line.

NETS.

Kinds.	Length.	Depth.	Size of mesh.	Twine.
	Fath.	*Fath.*	*Inches.*	
Trammel net (2)	15	2½	{ 2 { 6	35-3 12-16
Mackerel gill net	30	2½	3¾	16-6
Do	30	2½	3	16-6
Do	30	2½	2½	16-6
Menhaden gill net	15	2	3½	16-6
Do	15	2	2½	16-6
Shad gill net	50	4	4½	35-3
Do	50	4	4½	35-3
Cod gill net	100	2	7	40-10
Do	100	2	8	40-10
Herring gill net (2)	20	2½	2¾	20-6
Do	20	2½	2½	20-6
Red snapper gill net (2)	50	3	9	
Capelin seine	40	3½	{ 0¾ { 2½	12-6
Casting net				

DIP AND SCOOP NETS.

Kinds.	Bow diameter.	Handle length.	Number in outfit.
	Inches.	*Feet.*	
Dip nets for mackerel seine	29	10	2
Dip nets for torching, linen	23	7	12
Scoop nets with round bows for handling fresh fish	15	4½	6
Scoop nets with straight edge	14	4½	2

LABORATORY OUTFIT.

Antimony.
Arsenic.
Alum.
Acids, picric, chromic.
Anvil.
Brushes, water.
Bags, rubber.
Boxes, small assorted paper.
Boxes, nests, assorted.
Buckets.
Cloth, cotton cheese.
Clay for making casts.
Chisels, cold.
Chisels, mortising.
Cutters, wire.
Camera lucida.
Dippers, galvanized-iron.
Dippers, galvanized-iron, fine wire-cloth bottom.
Dishes, assorted, glass and earthenware.
Drills, twist, assorted.
Hammers, blacksmith's.
Hammers, riveting.
Hatchet.
Jars, with corks, eight sizes.
Jars, fruit, 1-pint, 1-quart, 2-quart.

Jars, butter, 2-pound, 4-pound.
Knives, cartilage.
Knives, dissecting.
Microscope, with accessories.
Nets, surface, silk bolting cloth.
Nets, surface, linen scrim.
Nets, tub strainer, linen scrim.
Paper, manilla.
Paper, straw.
Paper, English white tissue.
Pans, large, galvanized-iron.
Potash.
Plaster for molds and casts.
Presser, cork.
Rings, galvanized-iron, surface net.
Rings, brass, surface net.
Rule, millimeter.
Rule, common, 2-foot.
Rifle, 32 caliber.
Shotguns, 12 bore (2).
Shotguns, 10 bore (1).
Spades, trenching.
Spades, common.
Shovels, common.
Seives, assorted.
Scissors.
Tubs, wash, large size.
Tanks, copper alcohol, in boxes, 17 16-gallon, 20 8-gallon, 40 4-gallon.
Vise, hand.
Vise, bench.
Vials, homeopathic, assorted.

THE LIBRARY.

The ship's library contains over 300 volumes. Under the head of natural history, &c., there are 58 volumes; scientific, 57 volumes; publications of the United States Fish Commission, Smithsonian Institution, and National Museum, 48 volumes; miscellaneous, 36 volumes; navigation and nautical astronomy, 19 volumes; history and biography, 18 volumes; steam, 6 volumes; &c.

It was the intention to provide such works as would be useful in all the branches of investigation carried on by the vessel, text-books and professional works required for reference by naval officers, besides a few standard volumes of history and biography.

REMARKS ON THE OUTFIT, MESS FURNITURE, ETC.

It is customary in the naval service to provide a recruit with bag and hammock free of charge, his mattress and blankets being furnished by the paymaster and charged to his account. This expense although not very serious for a three years' recruit assumes greater importance when the term is for one year only, as with us, and to avoid running the men in debt to that amount we have adopted the plan of supplying them with mattresses and blankets without charge, holding them responsible for their proper care while in use, and their return to the ship before they receive their discharge.

Mess furniture for the cabin, wardroom, and steerage was furnished by the Commission as the simplest solution of a rather complicated situation which may be briefly stated as follows:

The officers of the ship detailed from the naval service would be expected to furnish their own mess furniture, bed linen, &c., according to custom, but the Commission would be obliged to provide for the naturalists, from one to half a dozen, who come and go as occasion requires, as it would be obviously unjust to require the officers of the ship to furnish them with the necessary outfit. Even this arrangement would

prove unsatisfactory from the difficulty of properly apportioning the mess expenses, hence the necessity for the following plan which has worked to the satisfaction of all concerned:

The Commission furnishes the quarters and mess furniture complete, as stated above, and pays to the officers' mess the uniform sum of $1 per day for subsistence of each person sent on board by competent authority. The same provision is made for them as for officers regularly attached to the vessel, and they are accorded equal privileges in the mess while temporarily attached to it.

G.—CO-OPERATION OF THE NAVY DEPARTMENT.

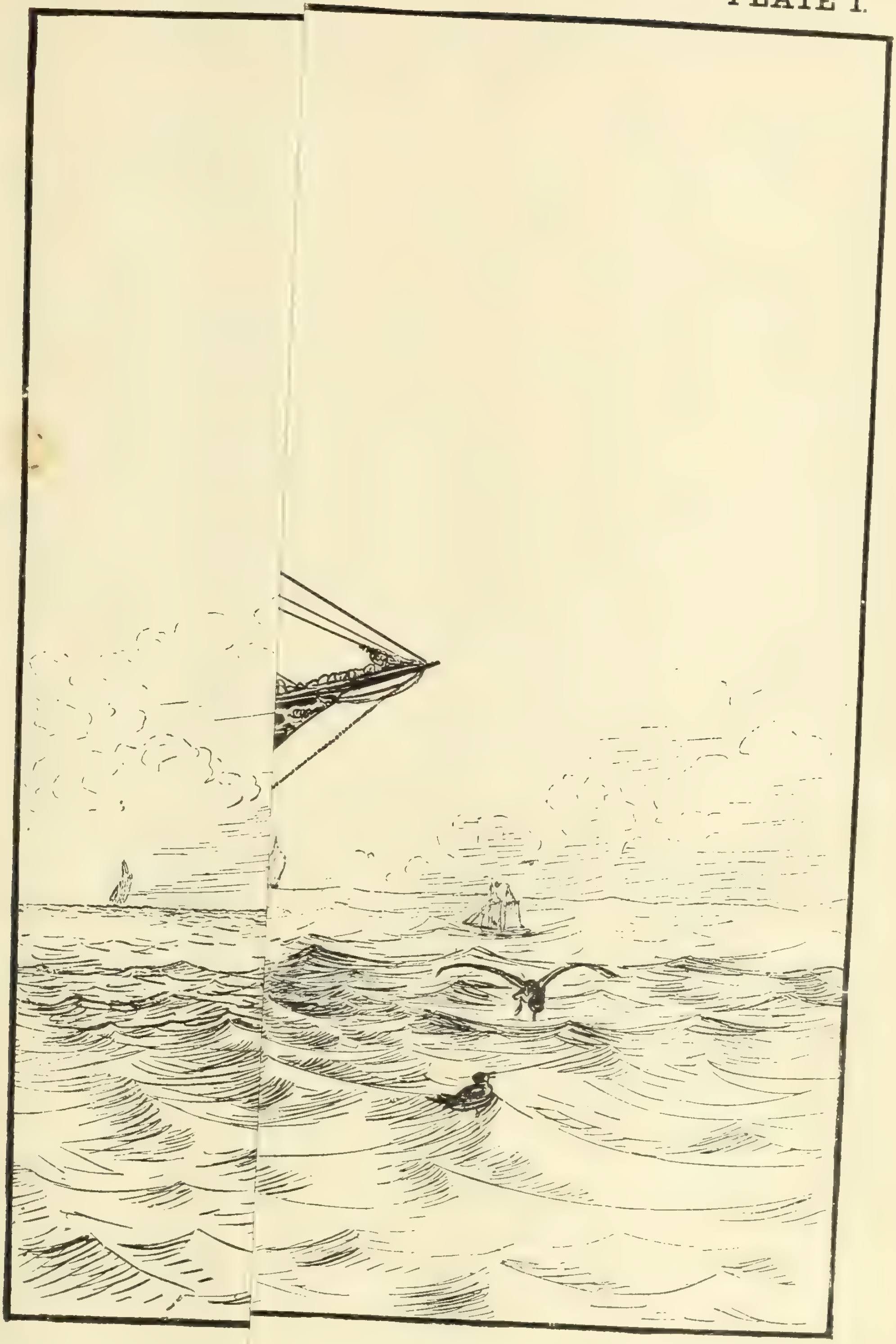
The officers and crew were furnished by the Navy Department in accordance with the act of May 31, 1880, and acting under Sec. 4397, act of February 9, 1871.

The Bureau of Equipment and Recruiting furnished anchors and chains, including mooring swivel, chain hooks, extra club link, spare shackles, implements, &c.

The Bureau of Navigation furnished 1 azimuth circle, 2 tripods, 2 liquid compasses, 1 set of navigation books, 1 set of charts, 1 hack chronometer, 1 course indicator, and 2 boxes of Very's night signals, with pistols, pouches, and frogs.

The Bureau of Ordnance furnished 1 3-inch B. L. rifle with complete outfit, including 75 charges of powder, 25 shells, 25 shrapnel, 50 boxer fuses, &c.; 6 Hotchkiss rifles with 1,200 cartridges, 9 revolvers and frogs, with 240 cartridges.

PLATE I.



The Albatross dredging.

PLATE II.

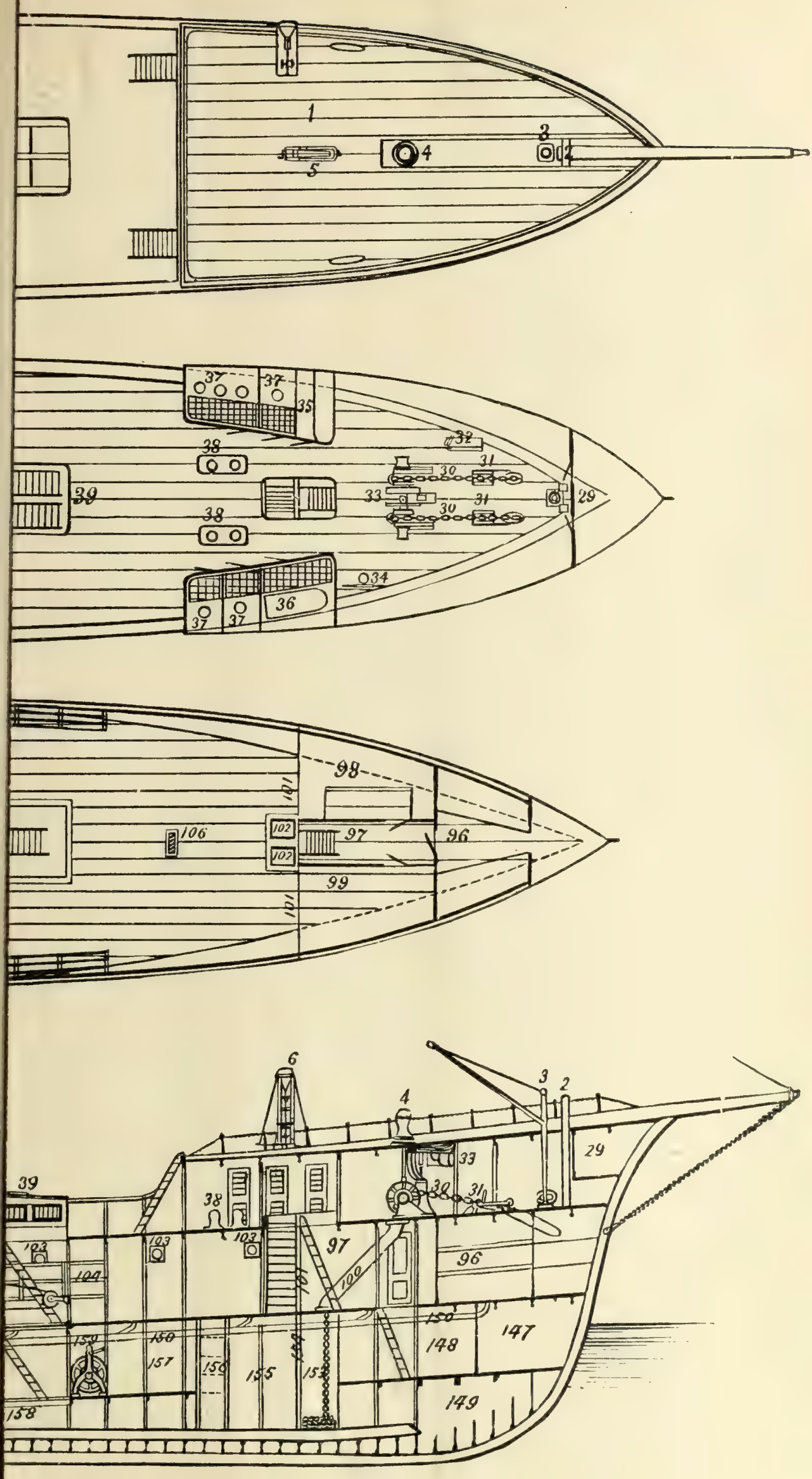

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FIG. 1. PLAN OF POOP-HOUSE & FORECASTLE DECKS.

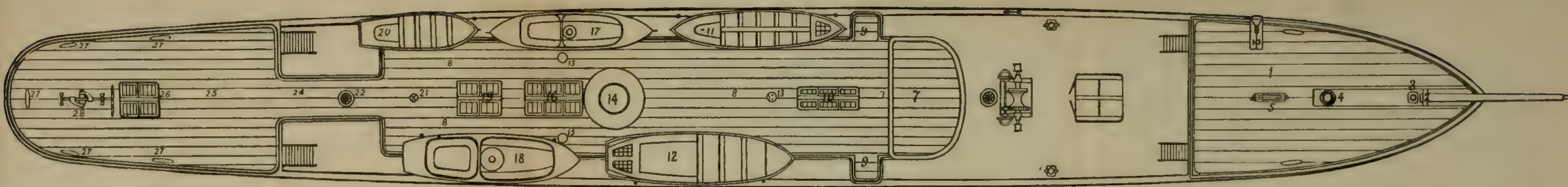


FIG. 2. PLAN OF MAIN DECK

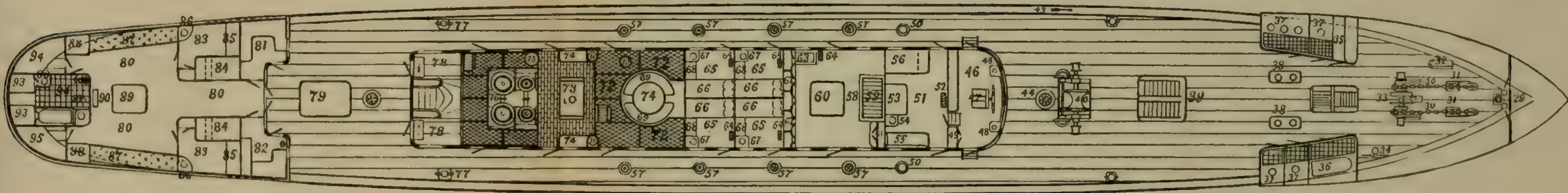


FIG. 3. PLAN OF BERTH DECK.

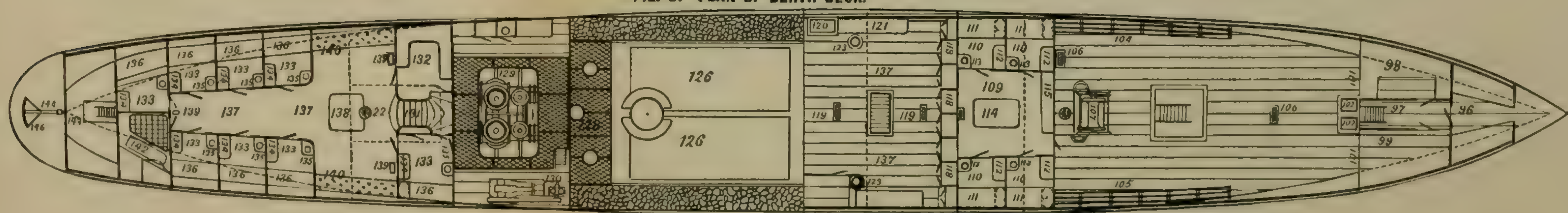
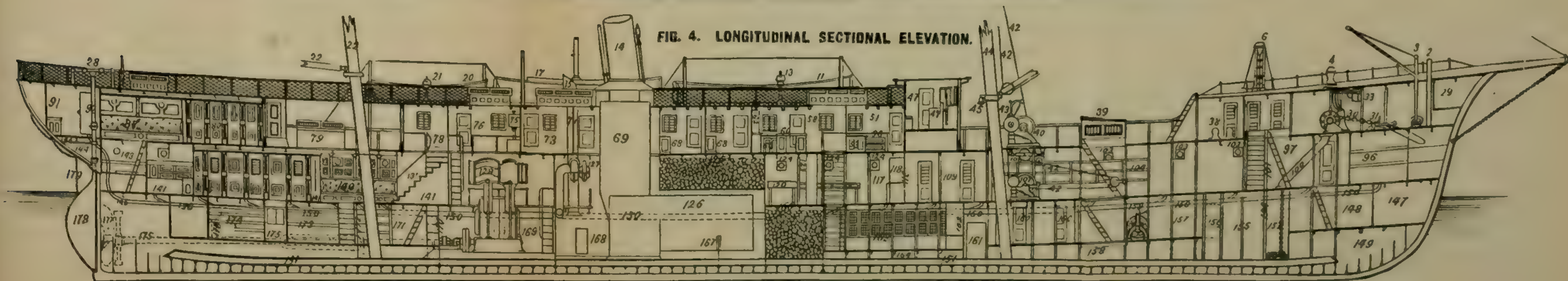
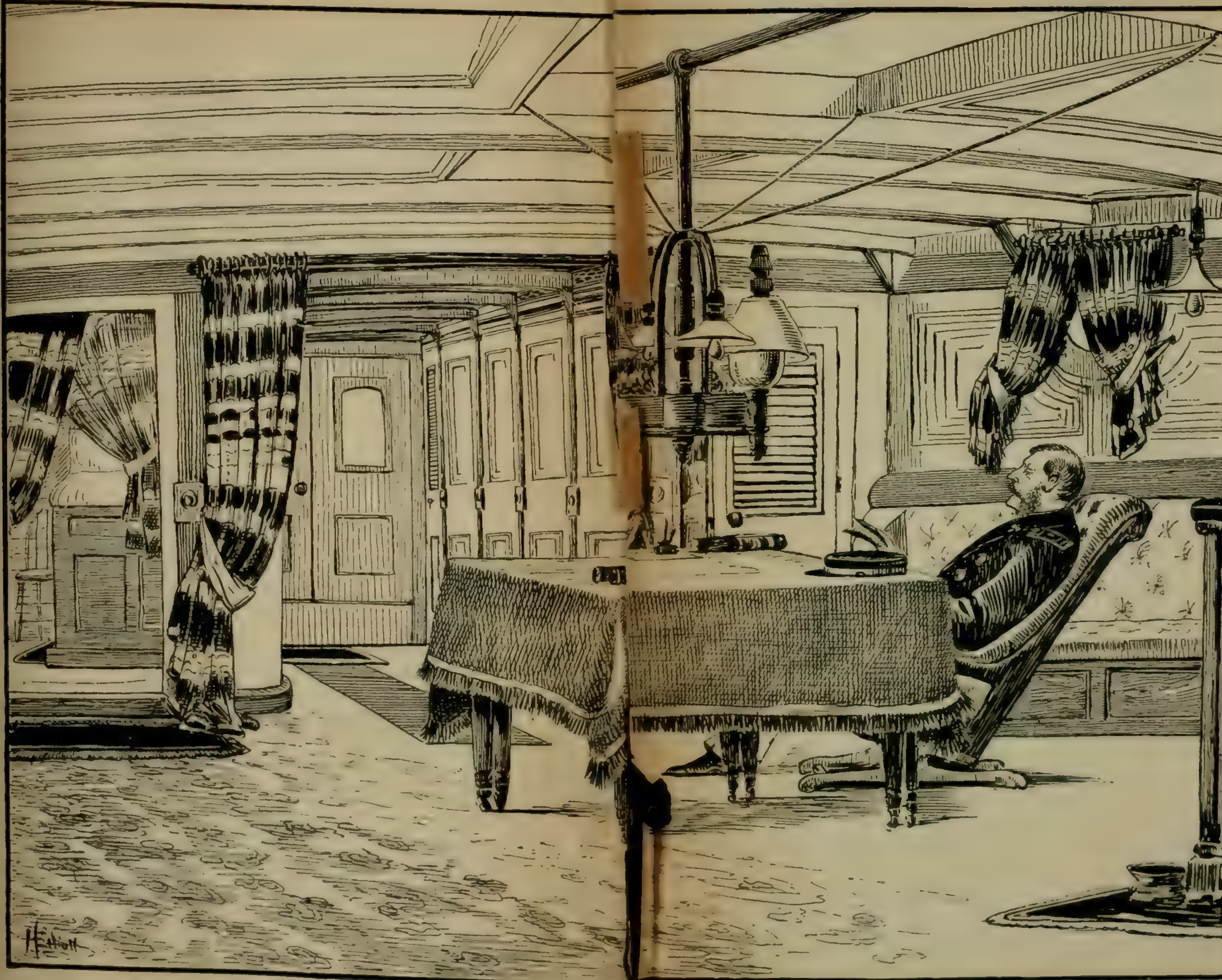


FIG. 4. LONGITUDINAL SECTIONAL ELEVATION.



Plans of the Albatross.



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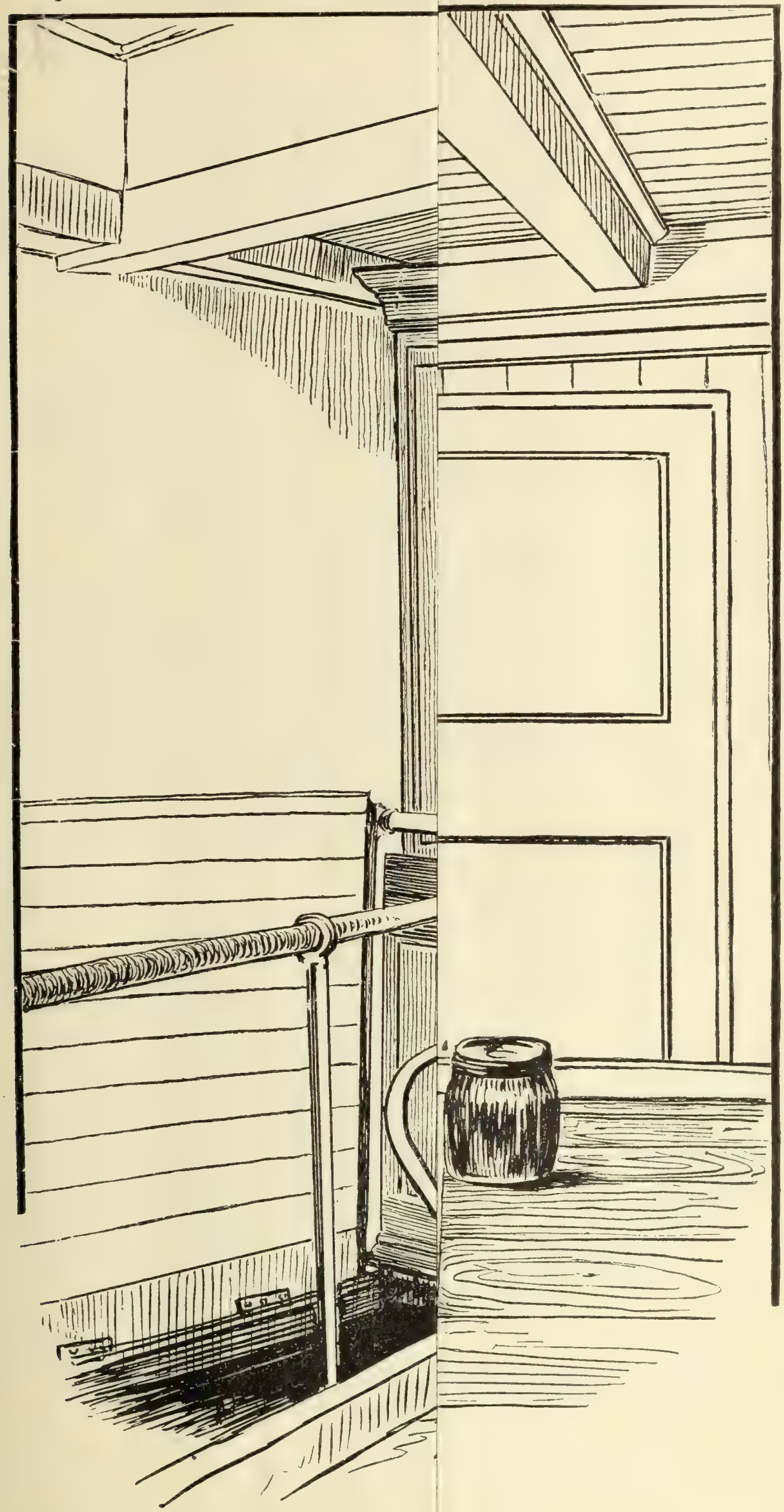
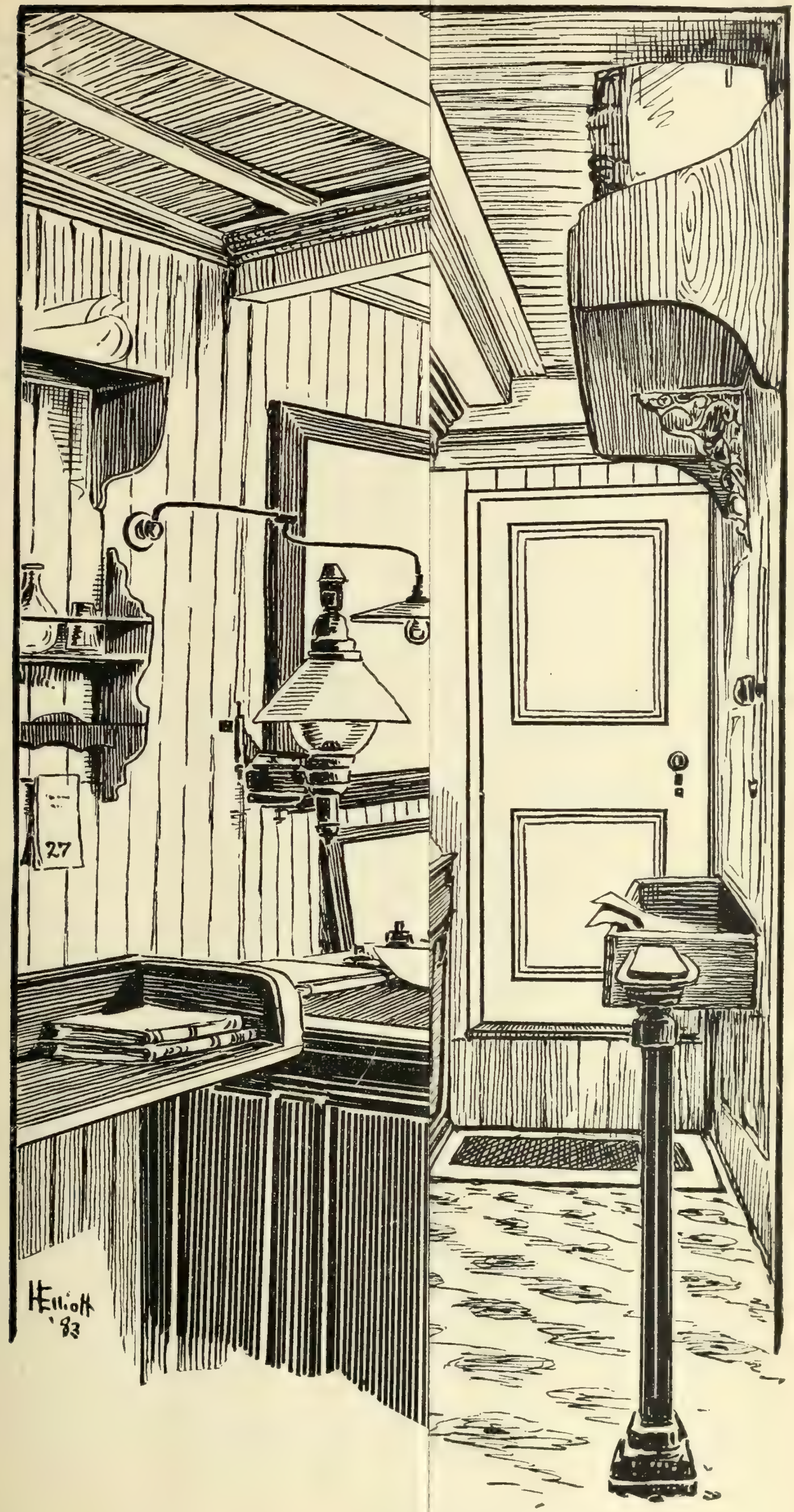


Upper laboratory.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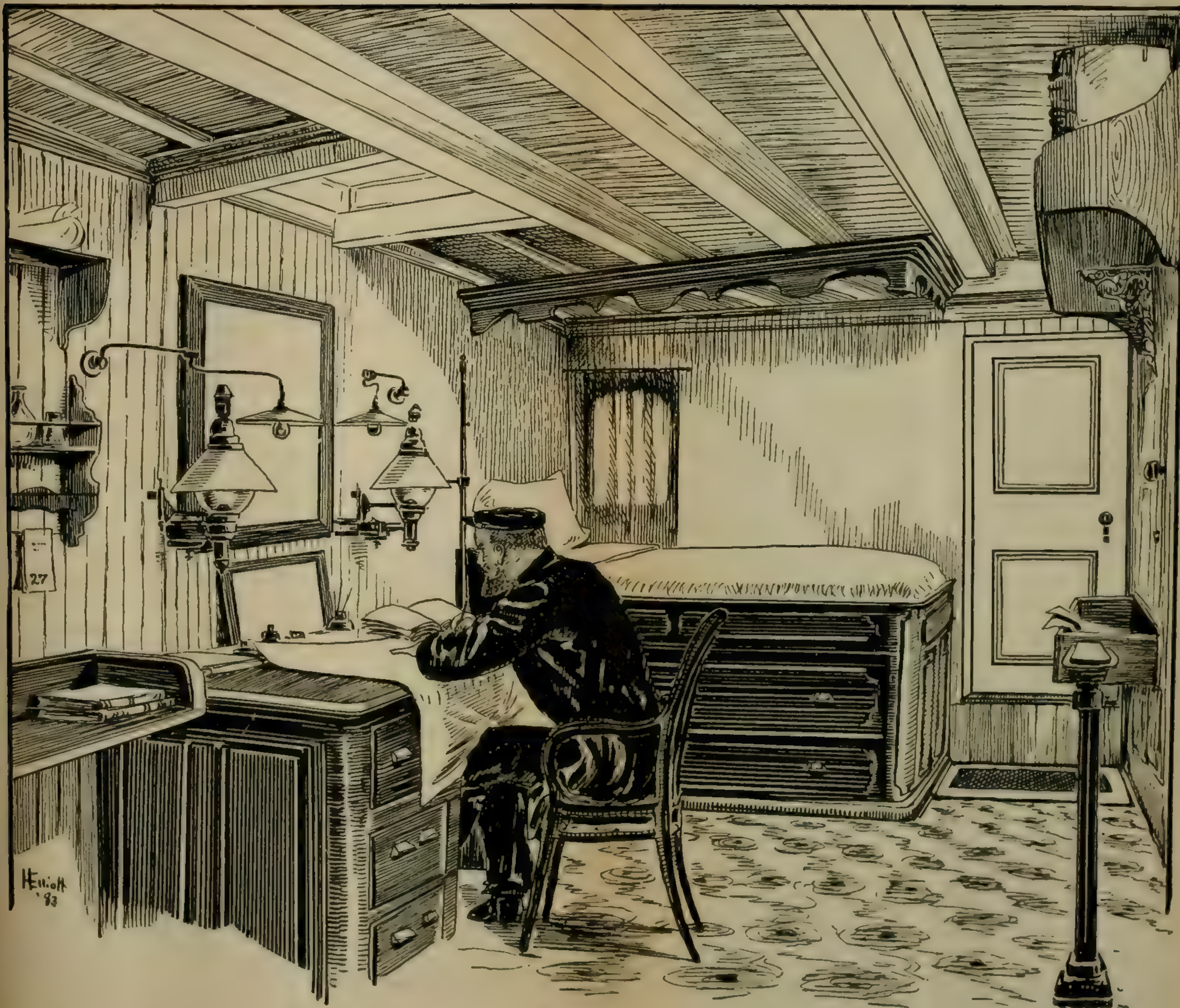
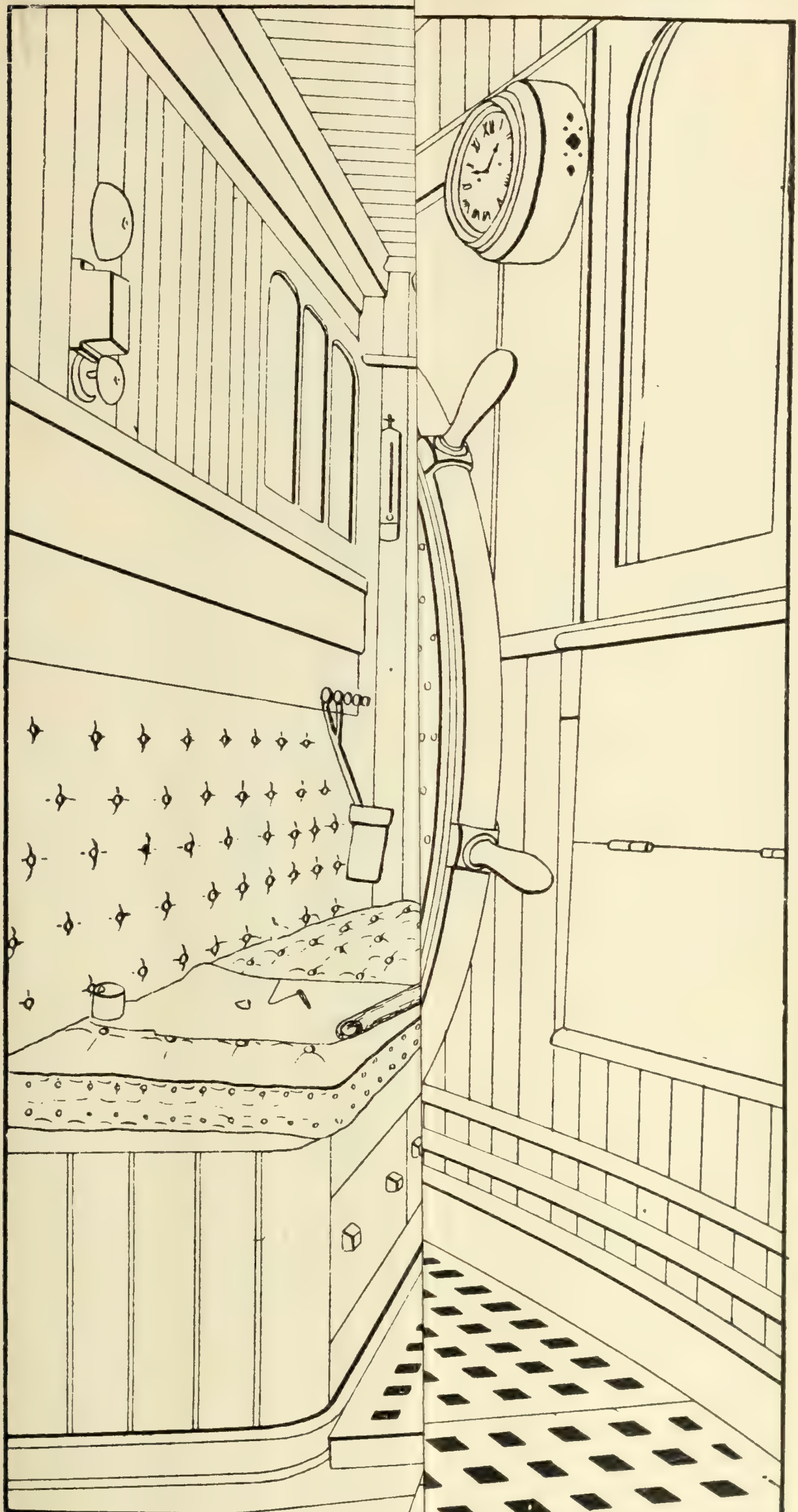
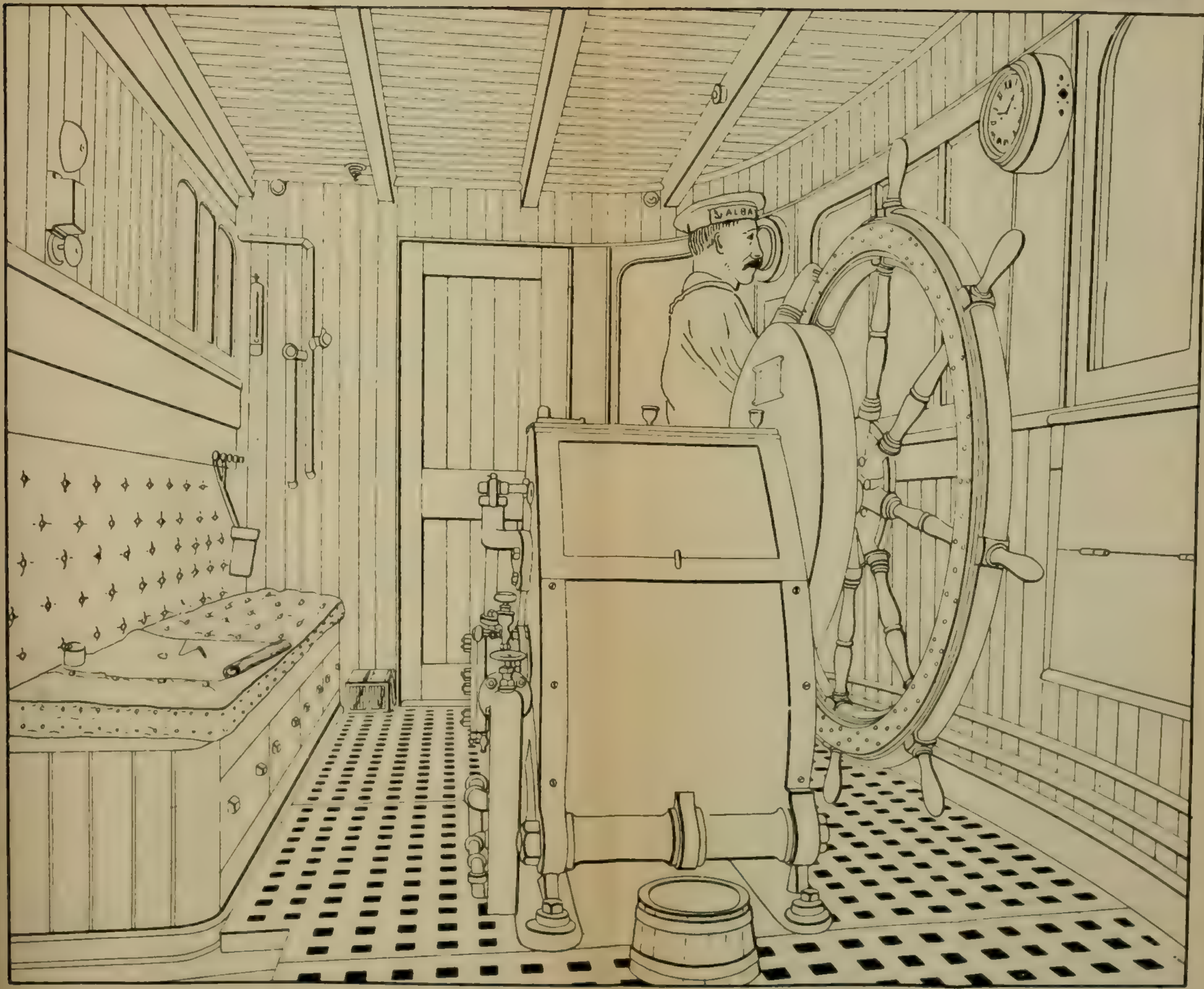
H Elliott
'83



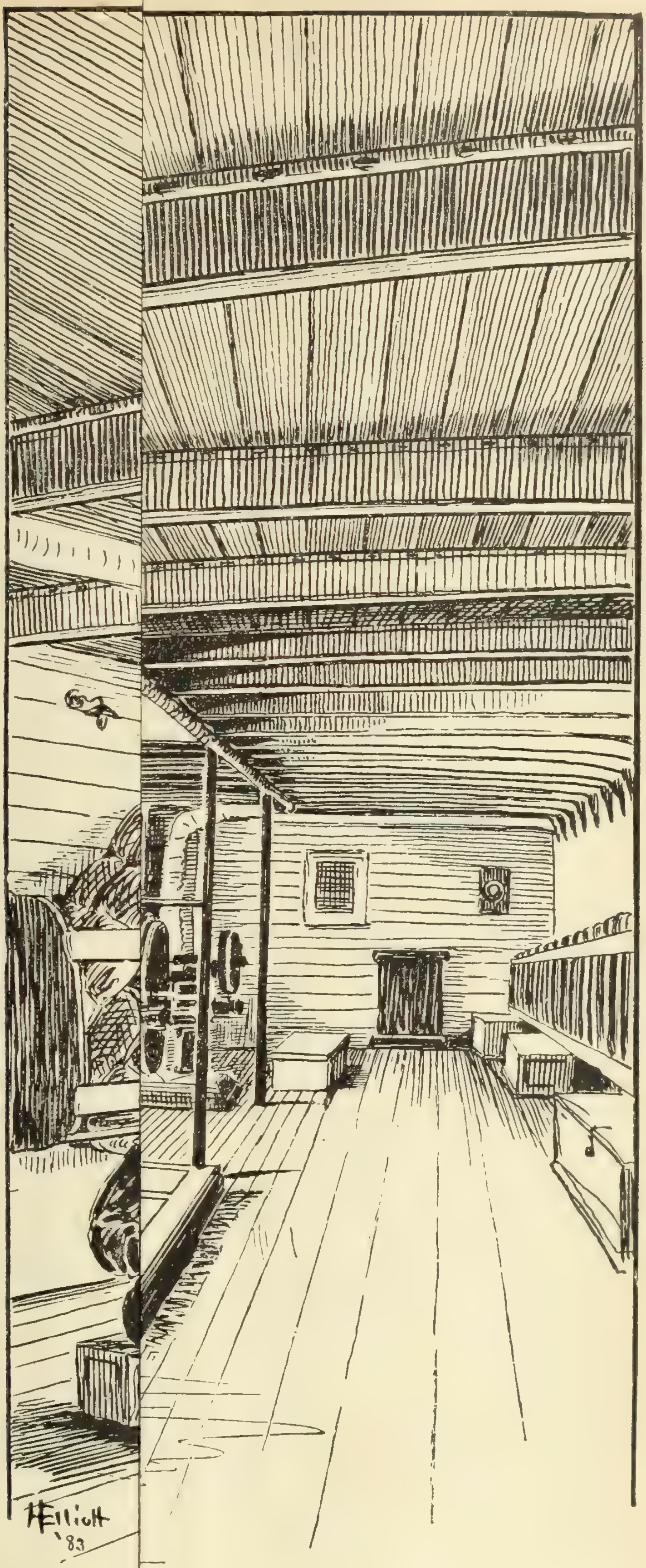
The chart-room.

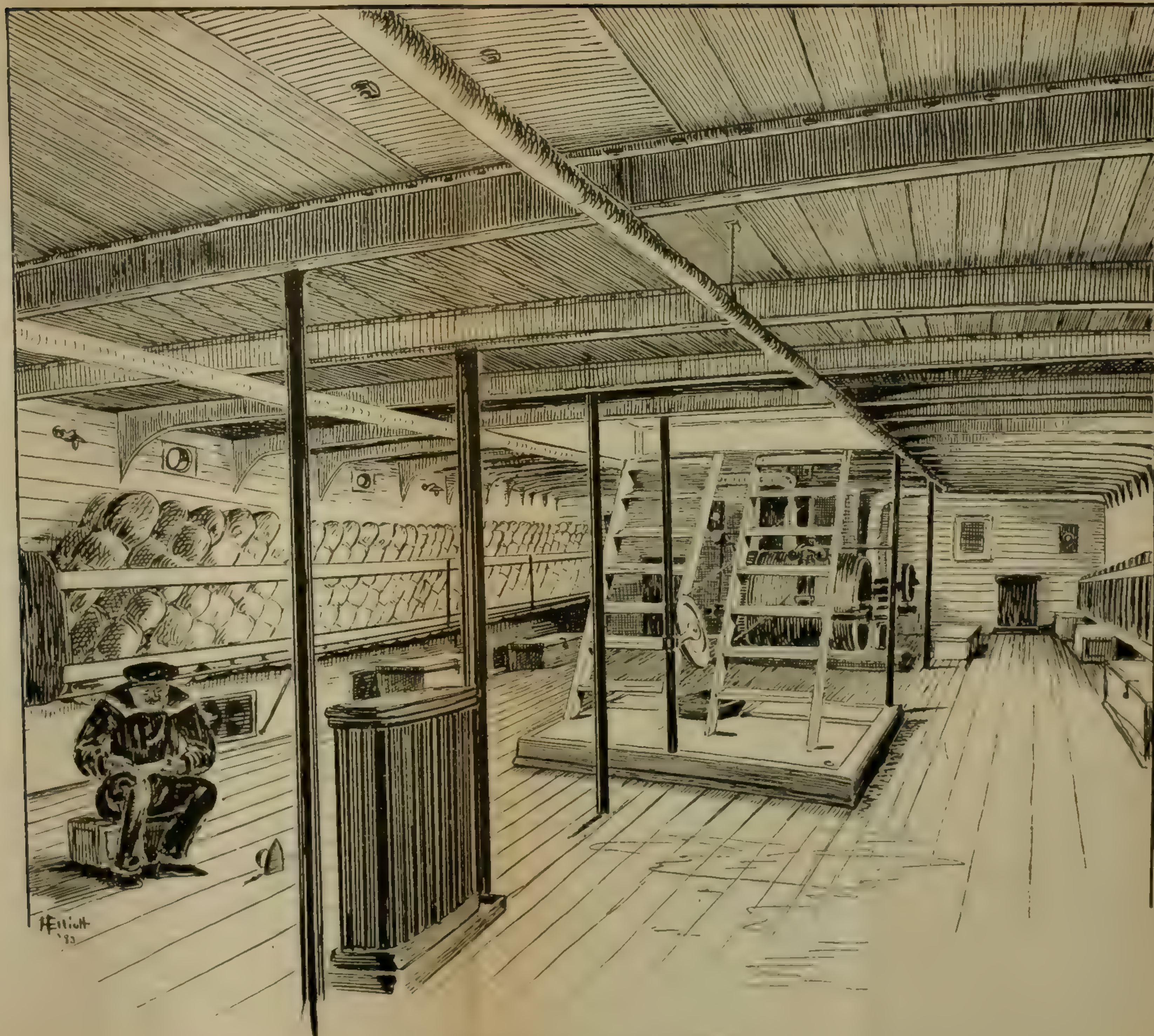
PLATE VI.



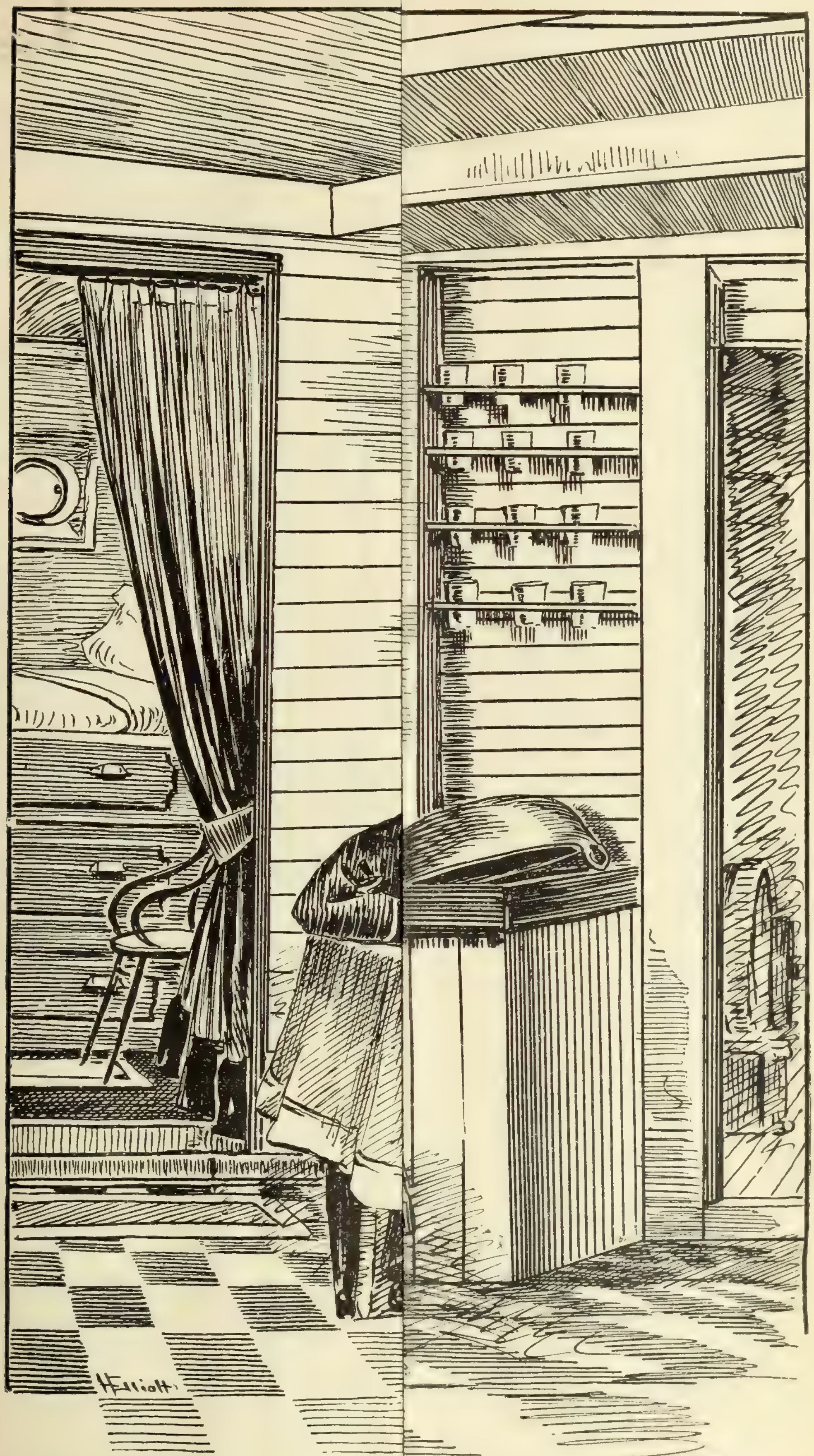


Interior of the pilot-house, steam steering engine.


H Elliott '83



Berth deck, looking from forward aft.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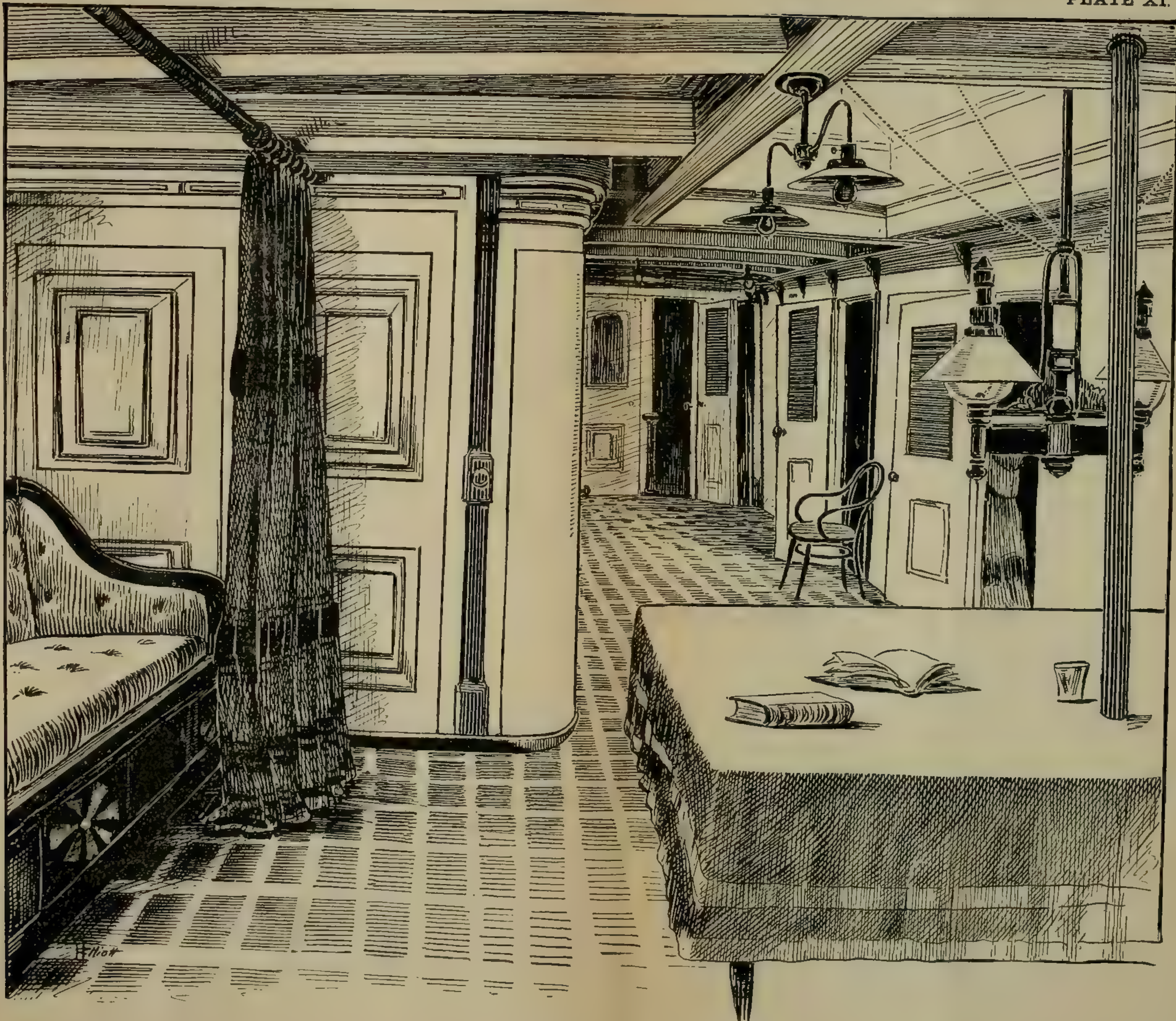
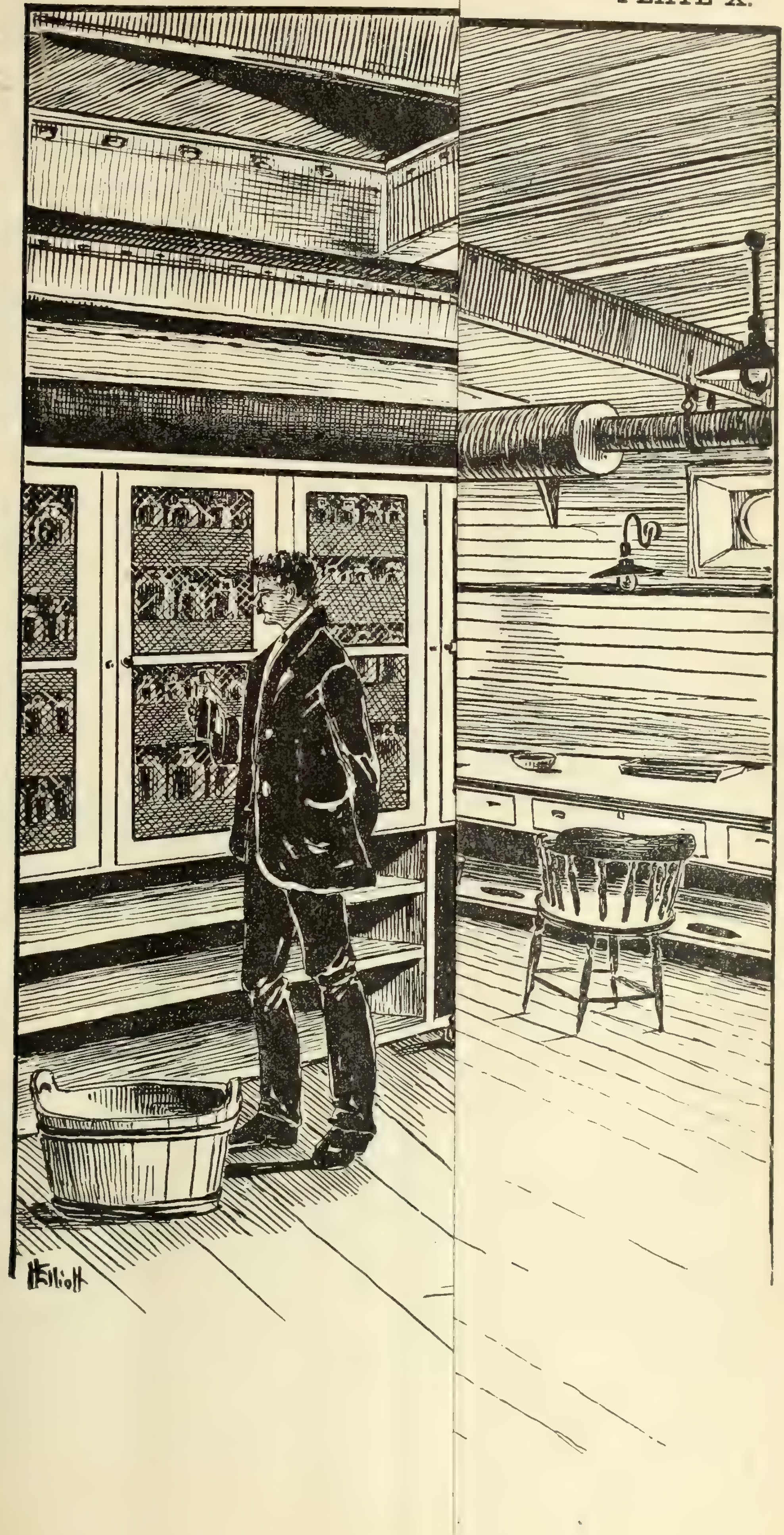
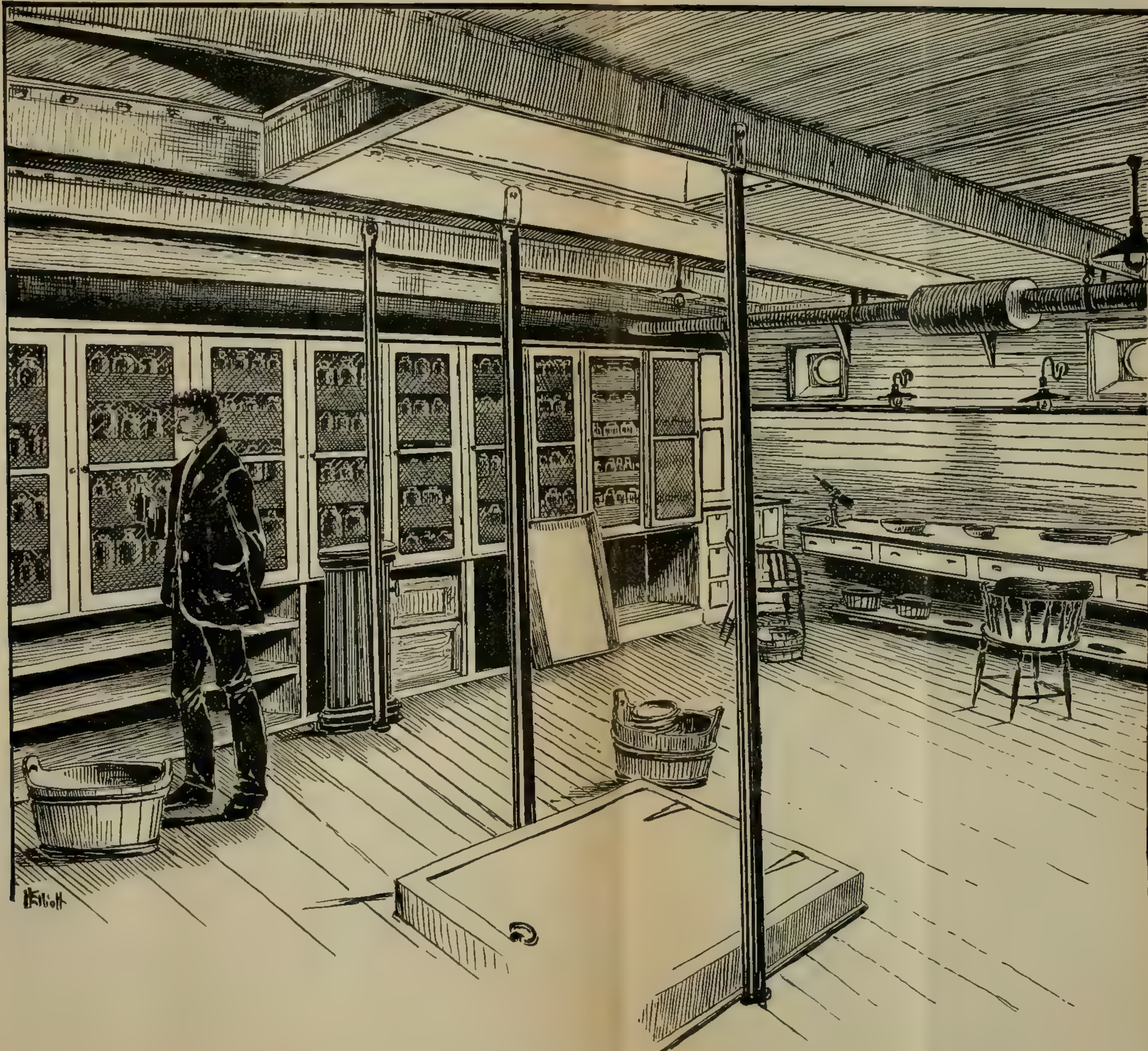


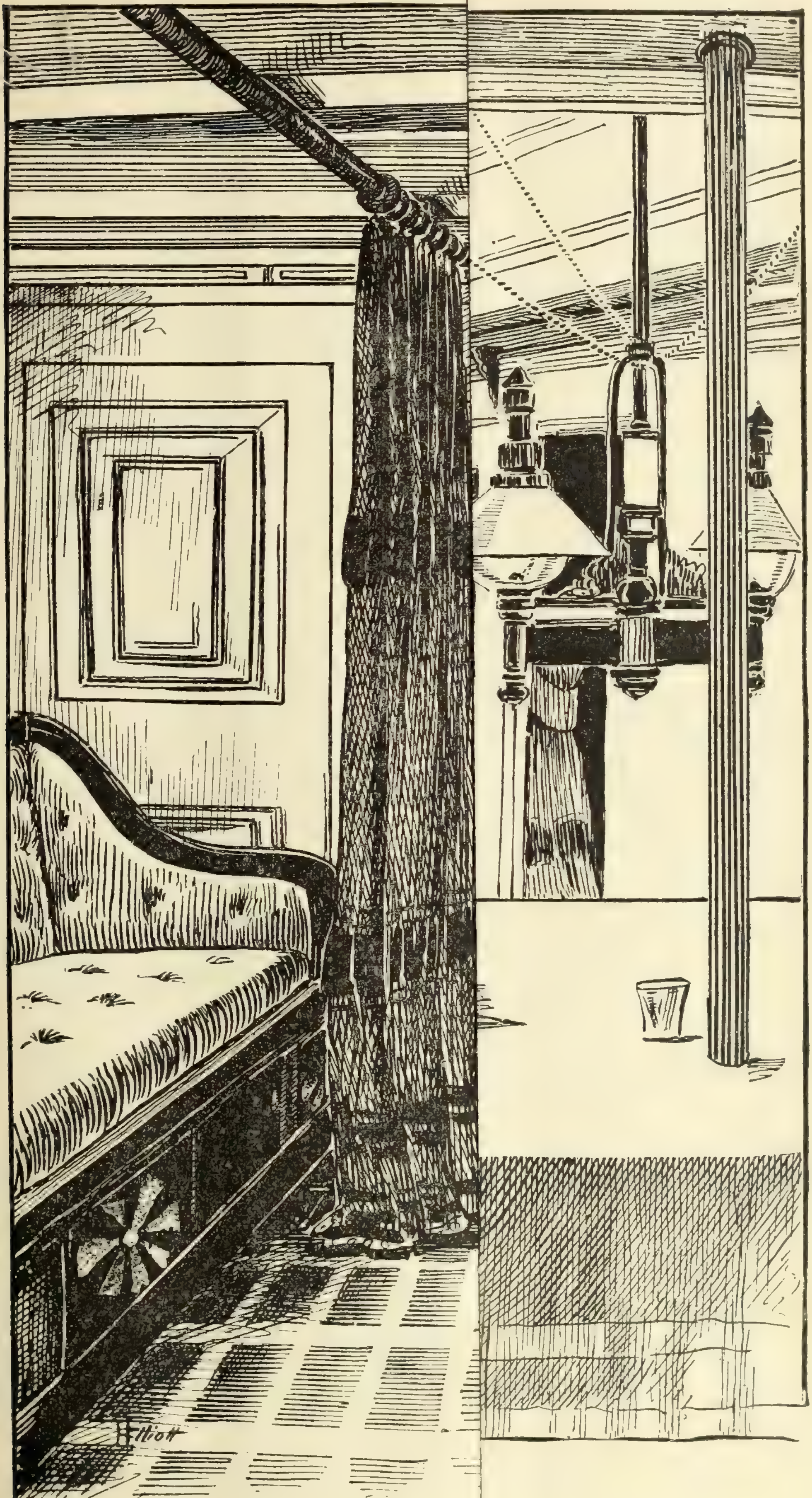
The ward room.

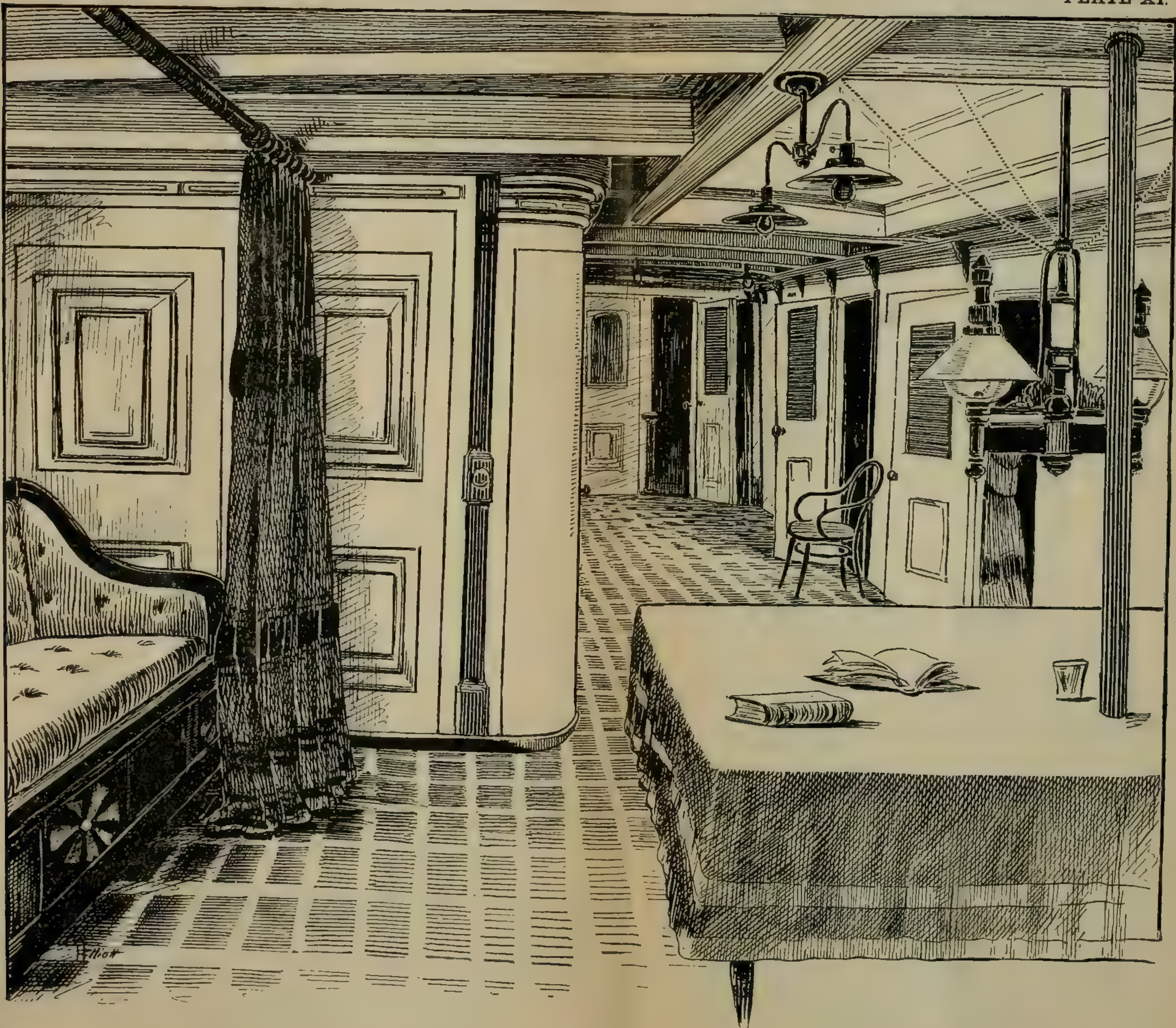
PLATE X.



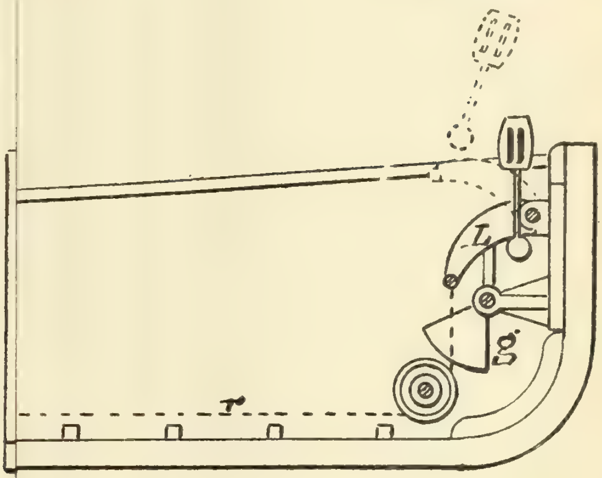


Lower laboratory, looking from aft forward.


Elliott



The ward room.



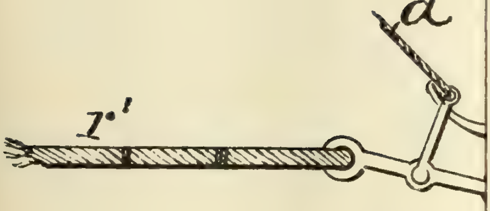


Fig.

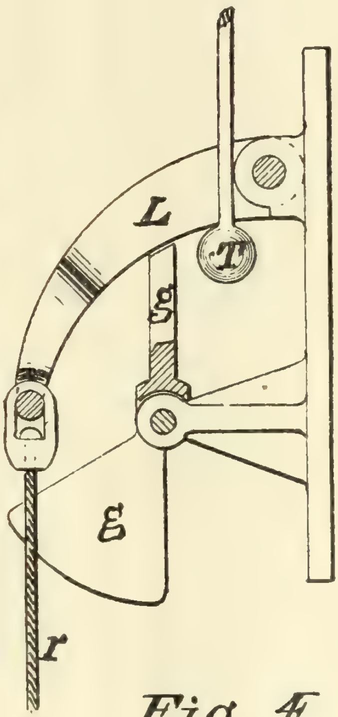


Fig. 4.

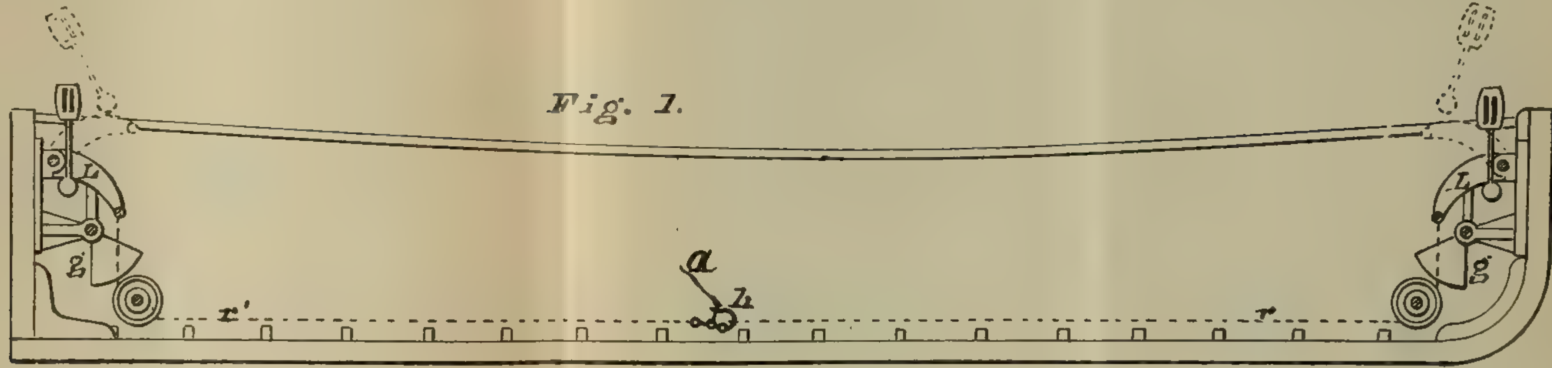


Fig. 1.

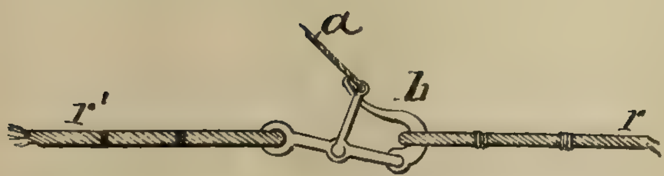


Fig. 2

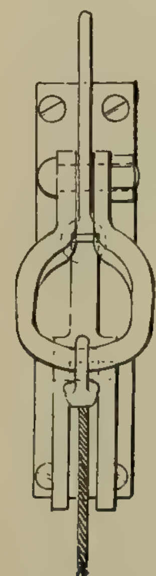


Fig. 3

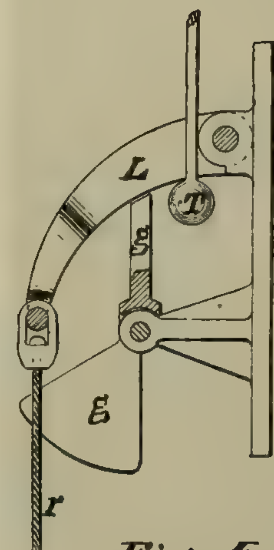
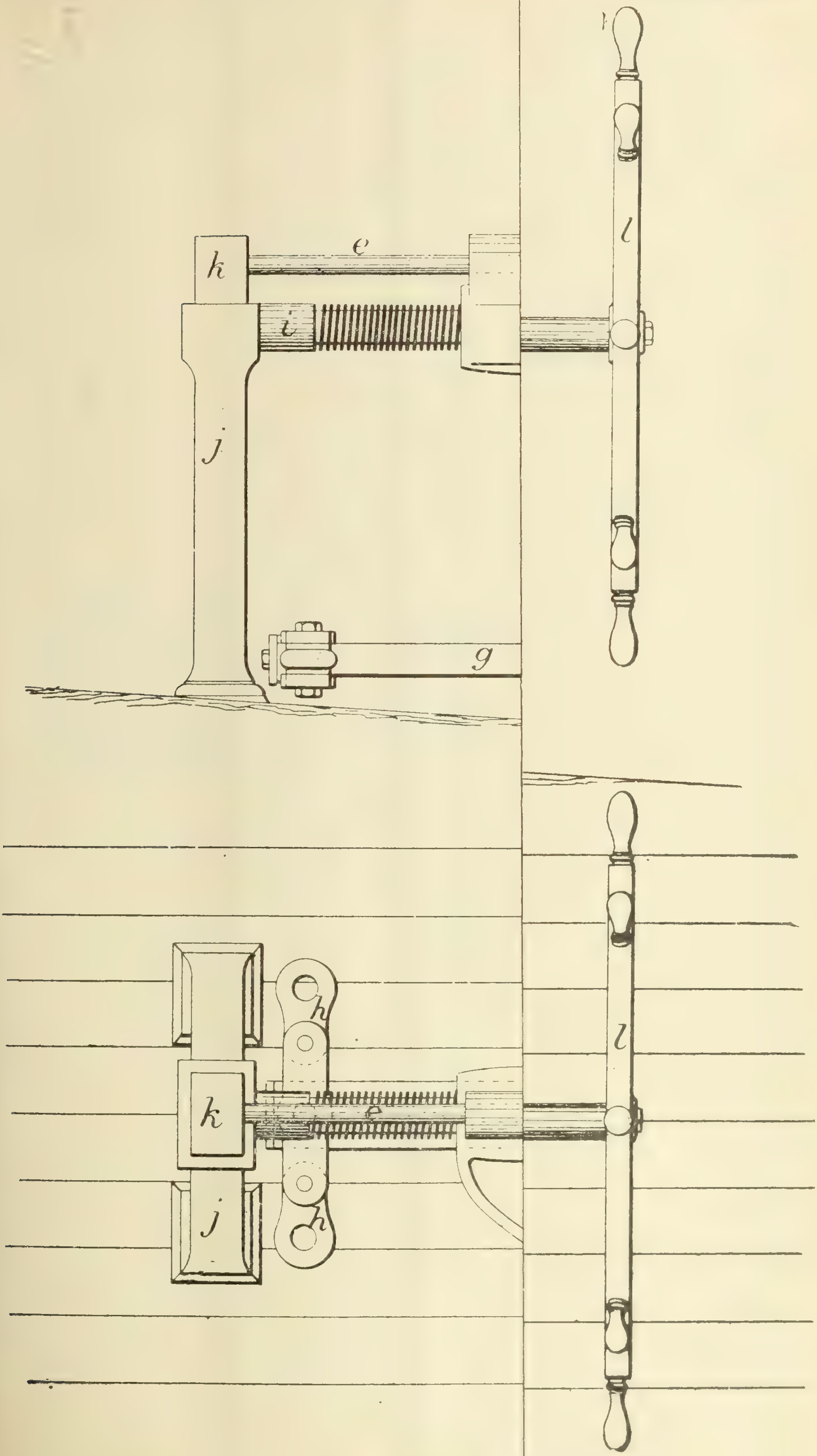


Fig. 4.

Lieut. W. M. Wood's boat-detaching apparatus.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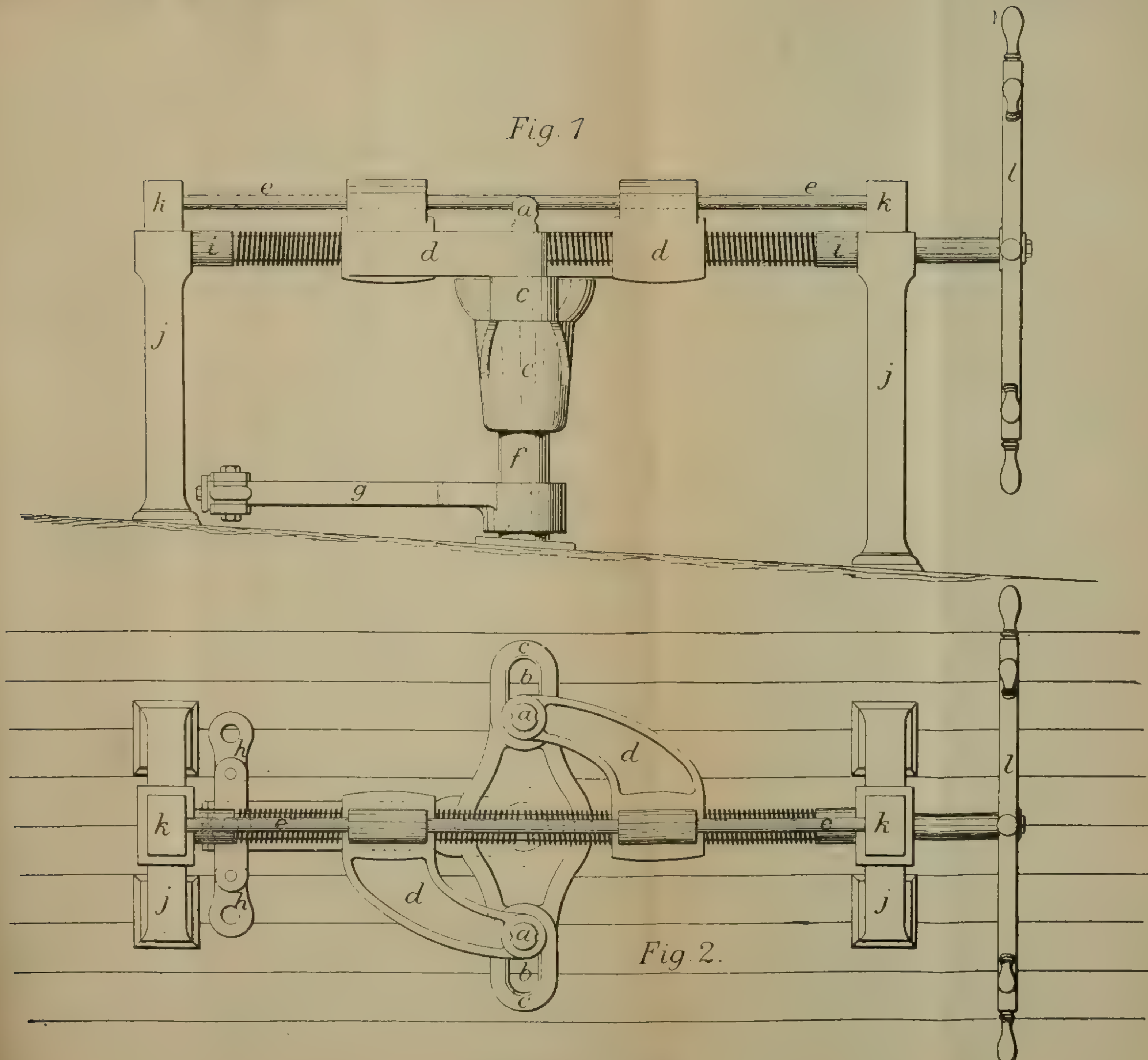
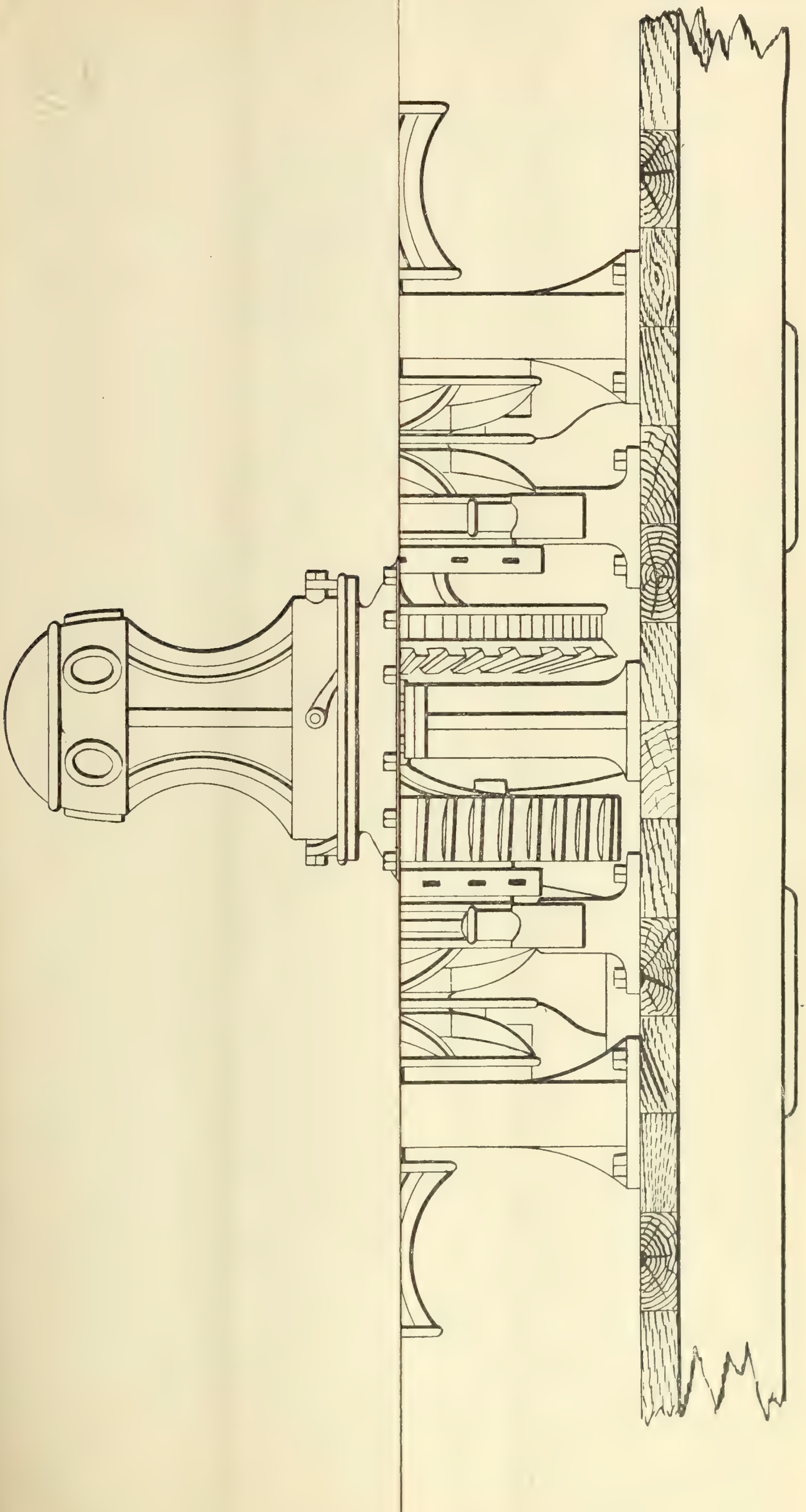
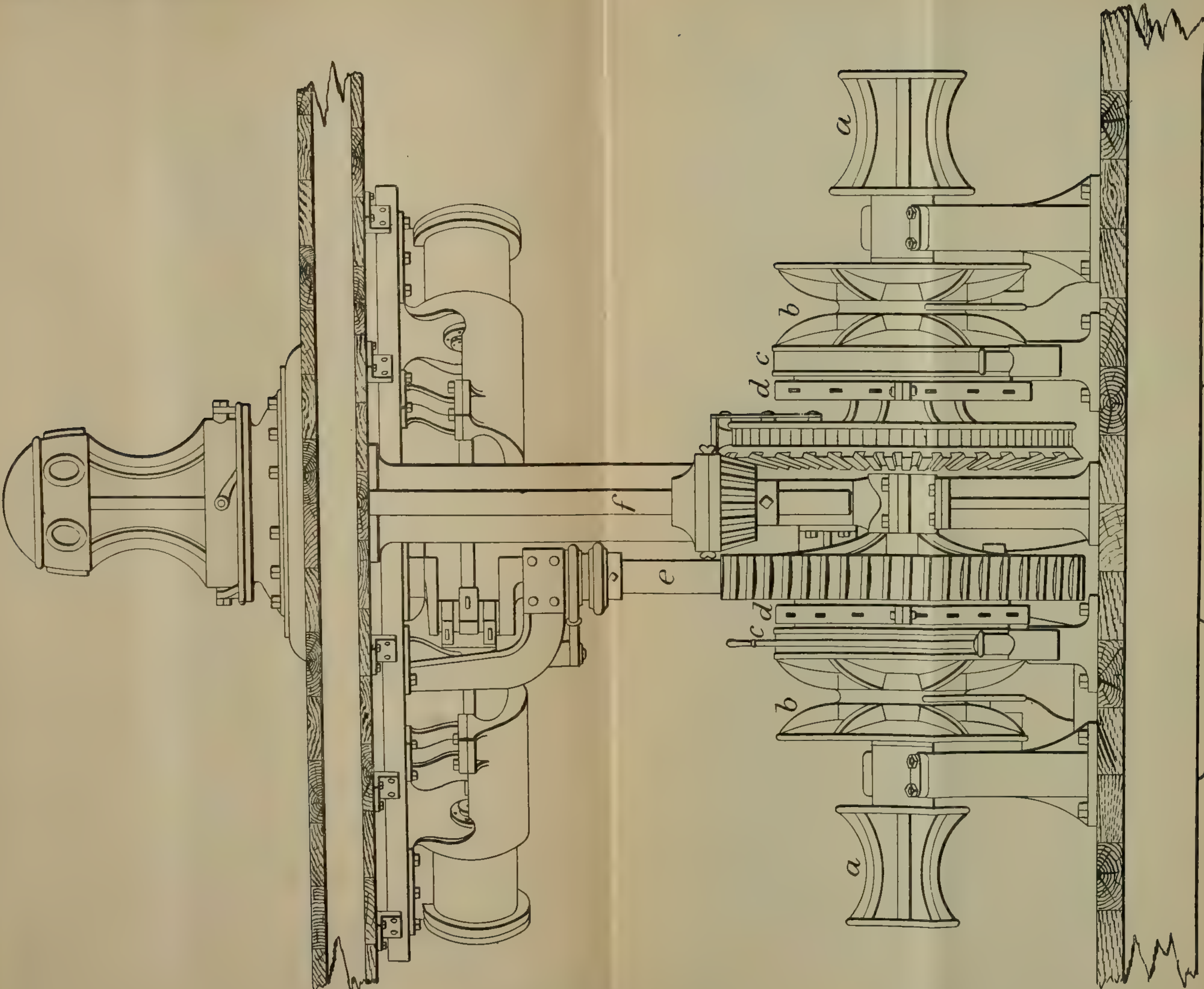
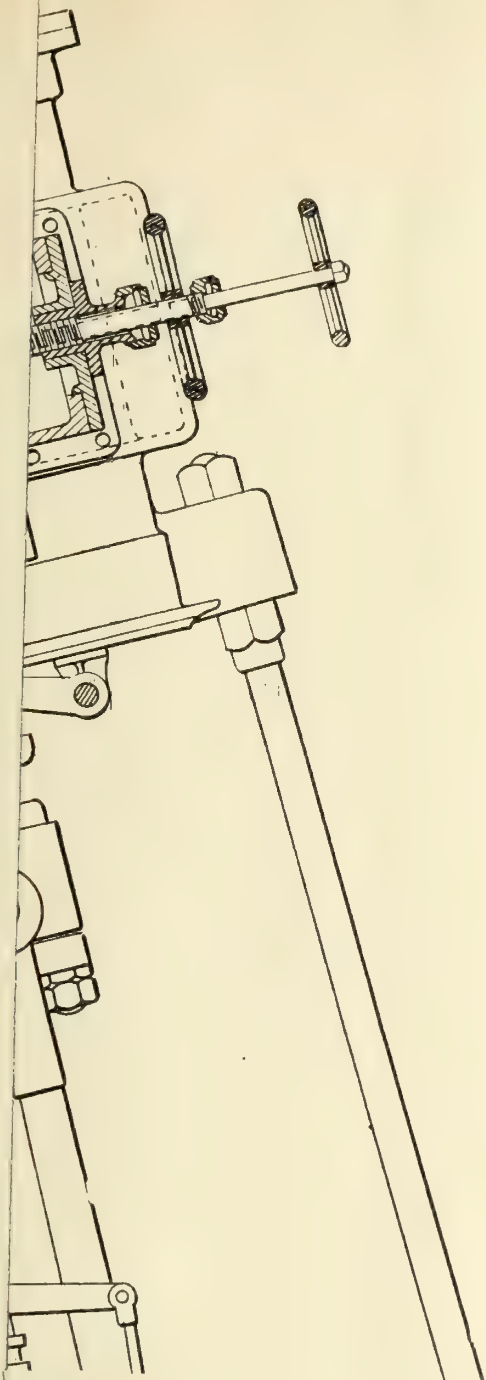


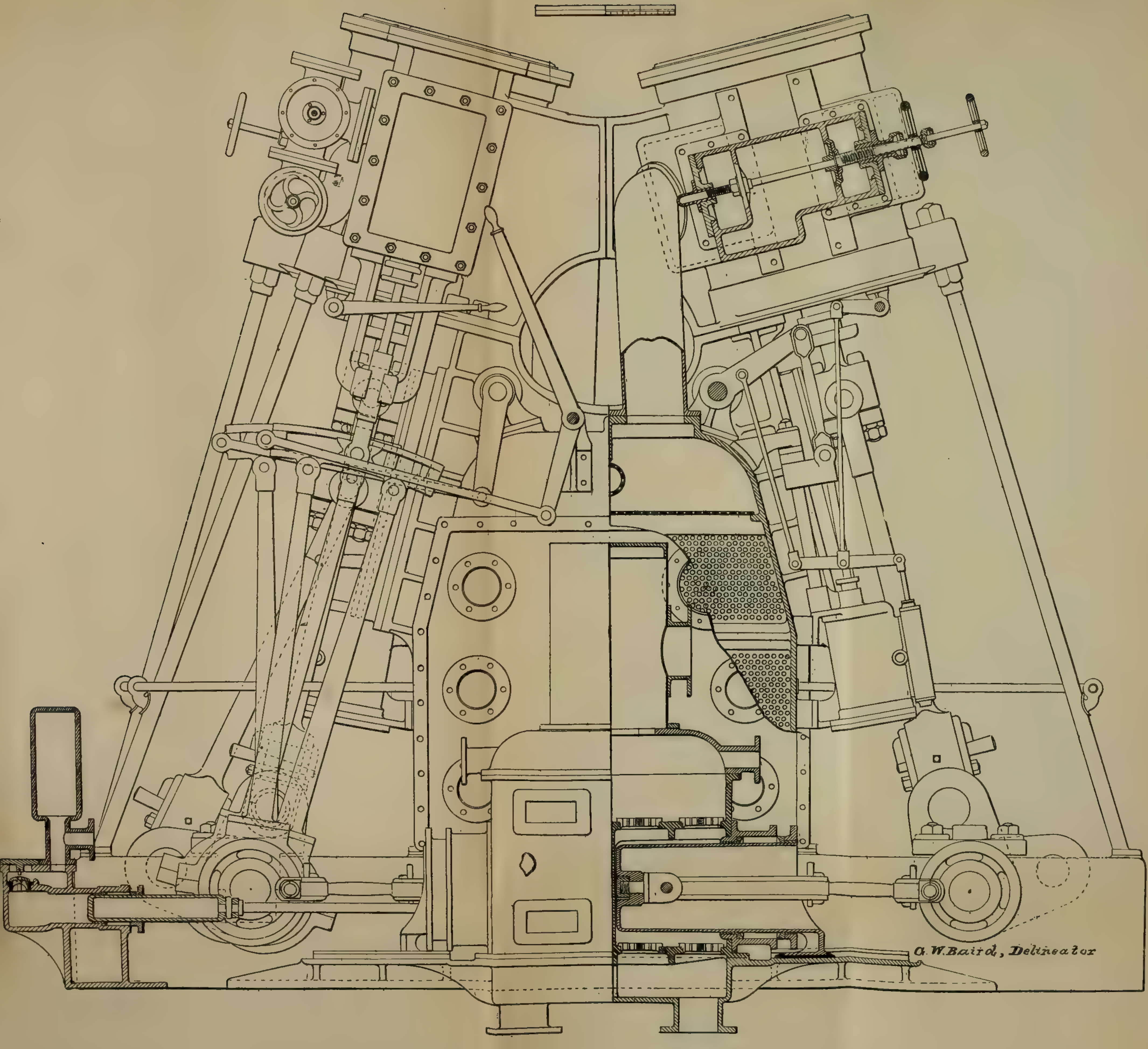
Auxiliary steering gear.





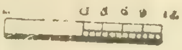
Steam windlass and capstan.



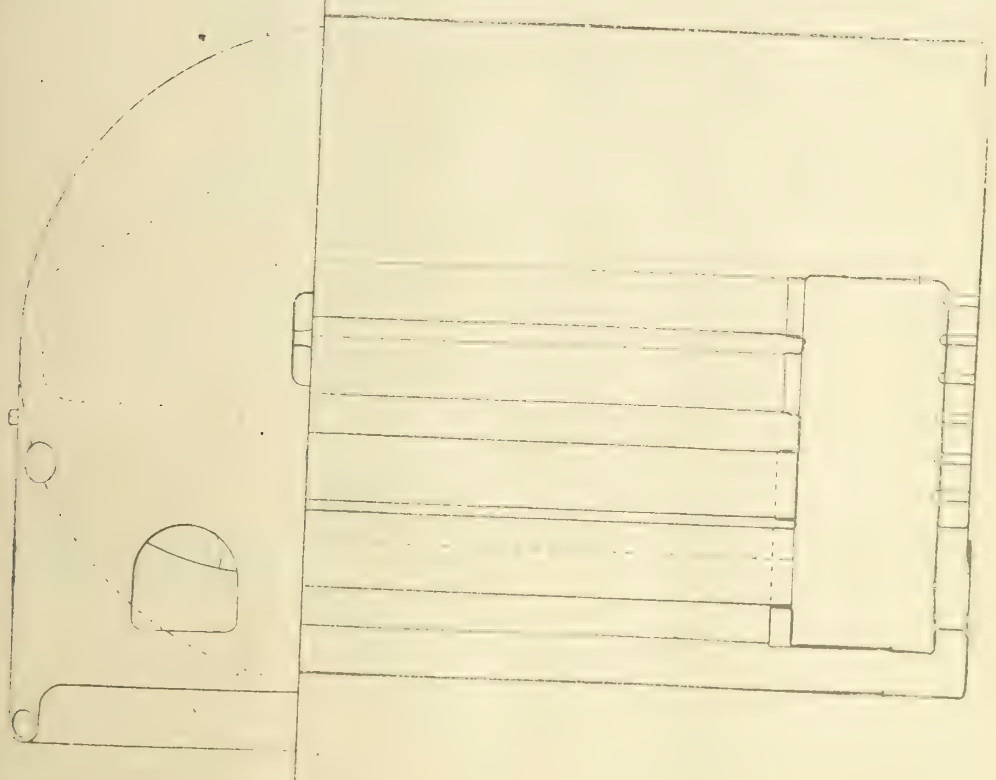


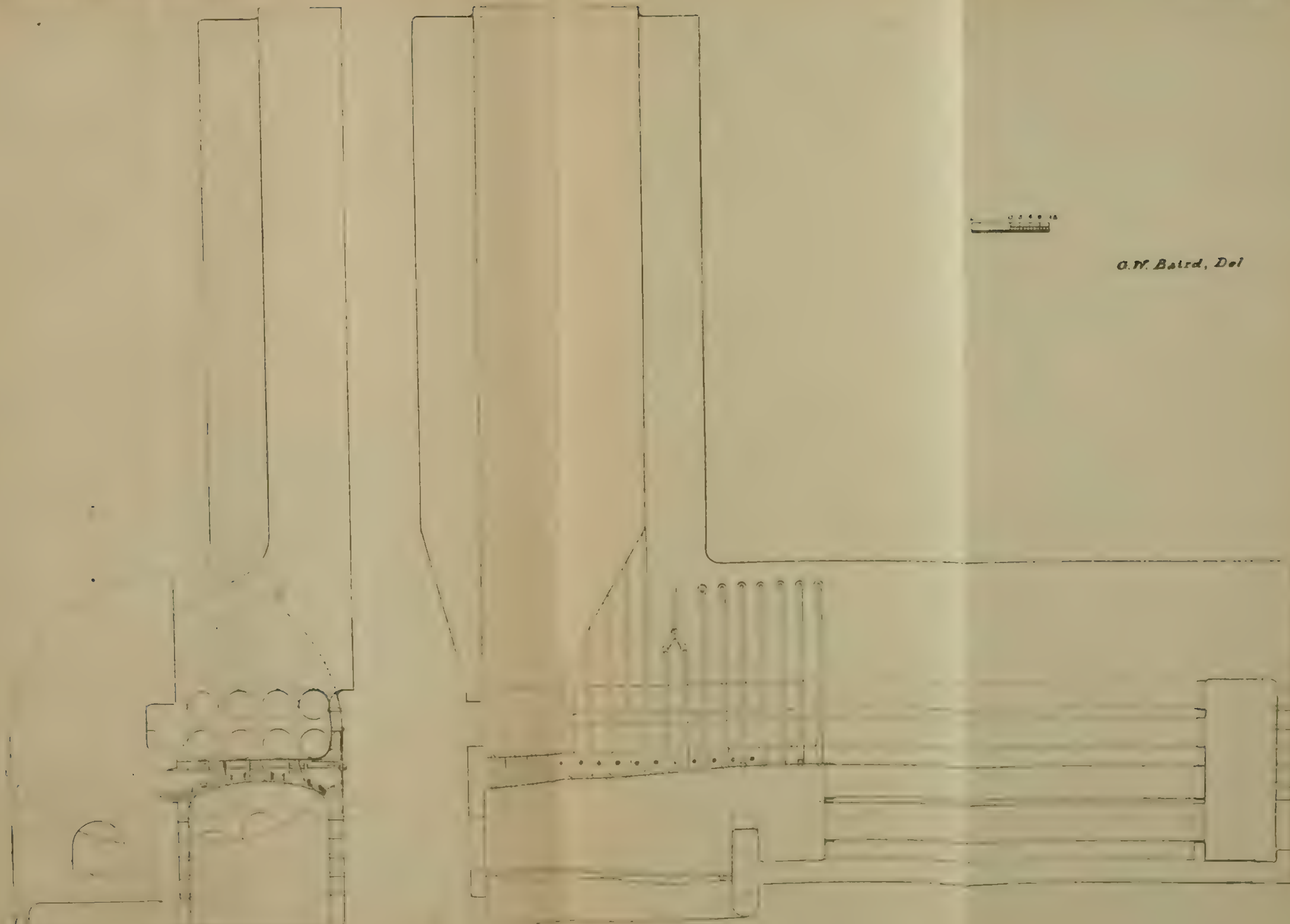
Compound twin-screw engines of the U. S. Fish Commission steamer Albatross.

PLATE XVI



G. W. Baird, Del

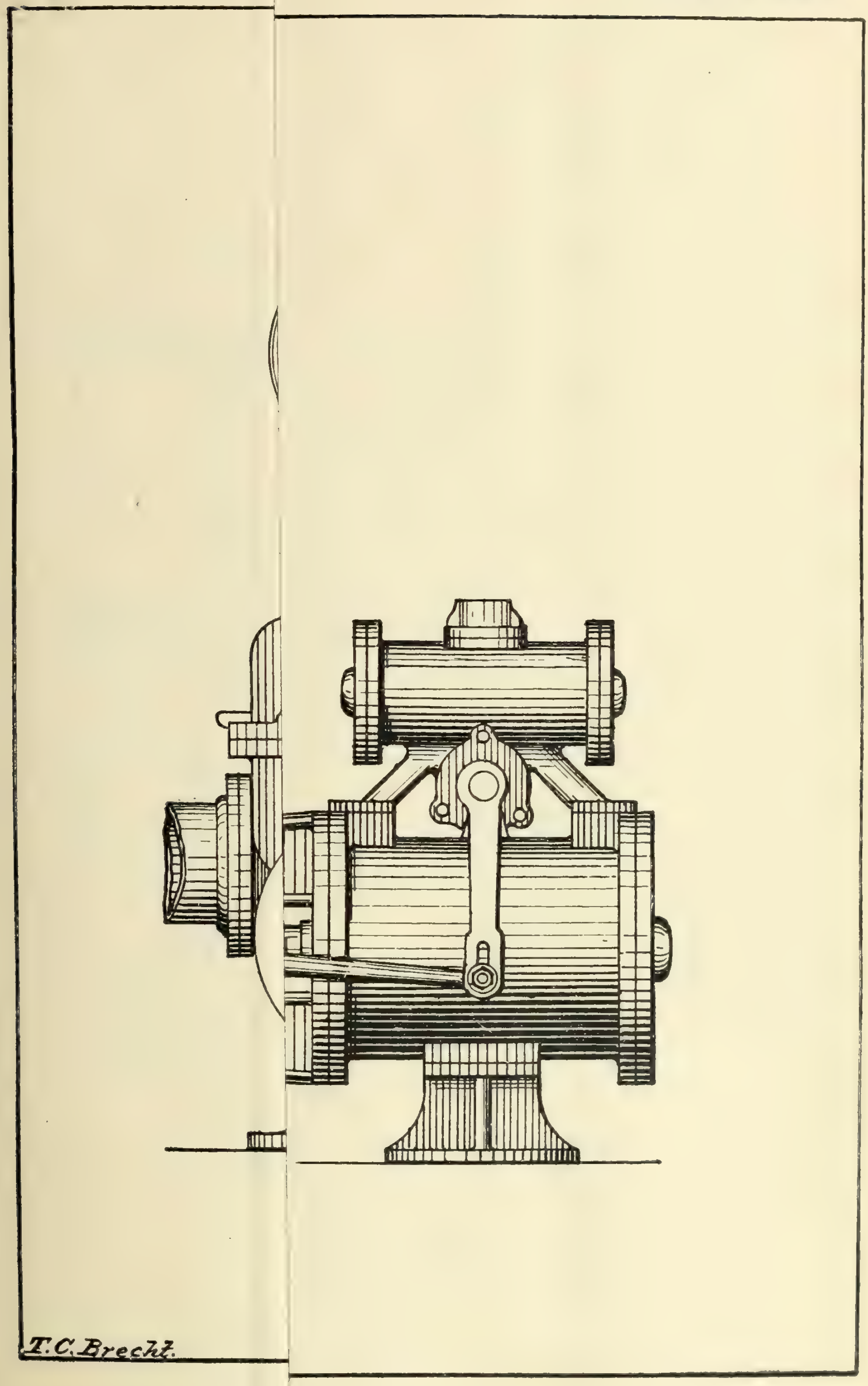


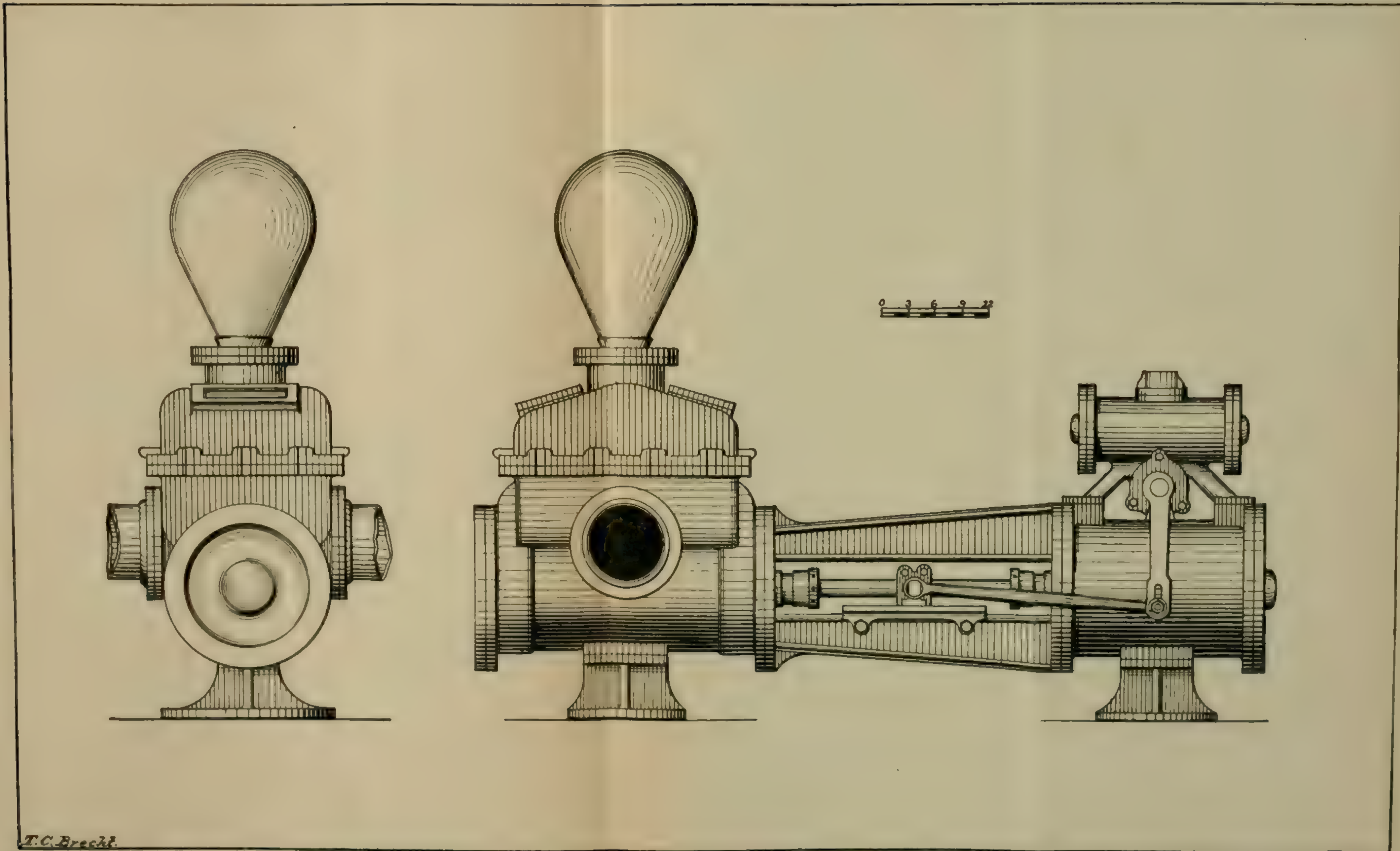


G. W. Baird, Del.

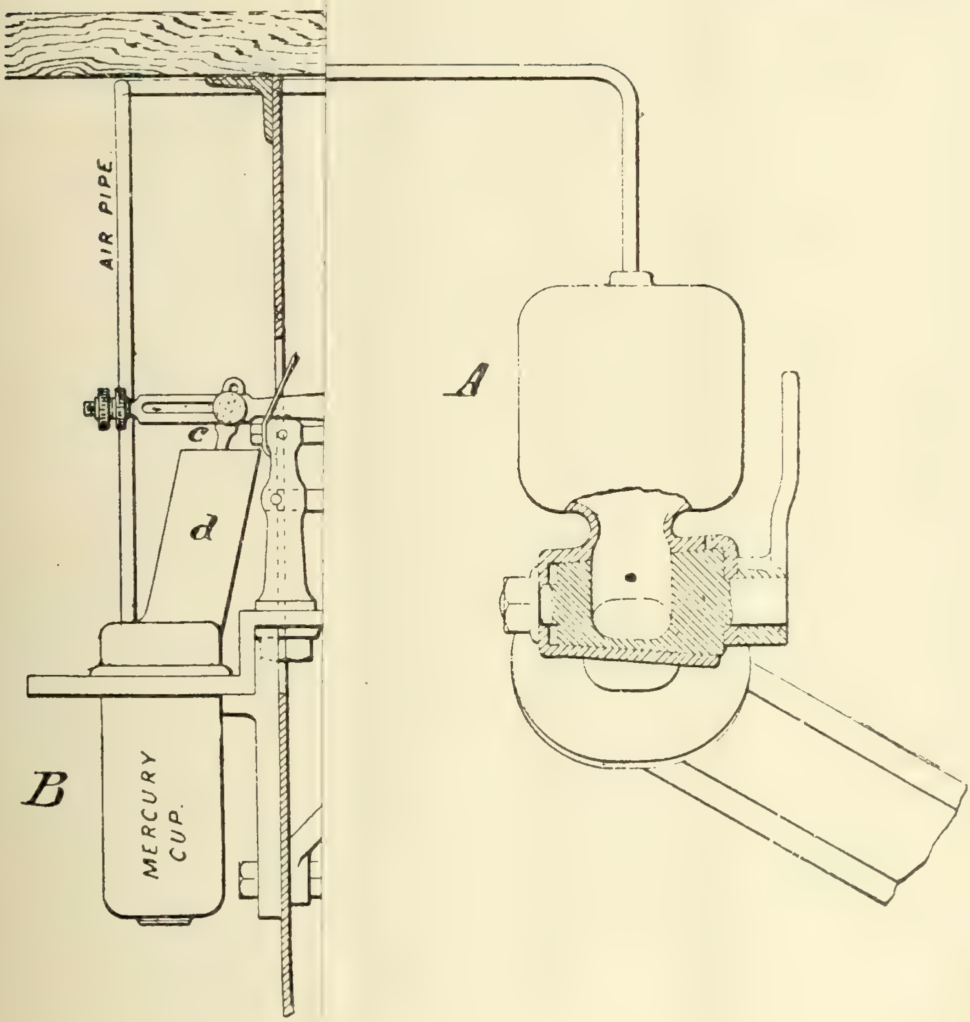
Plan of return-flue boiler

PLATE XVII.





Circulating pump.


AIR PIPE
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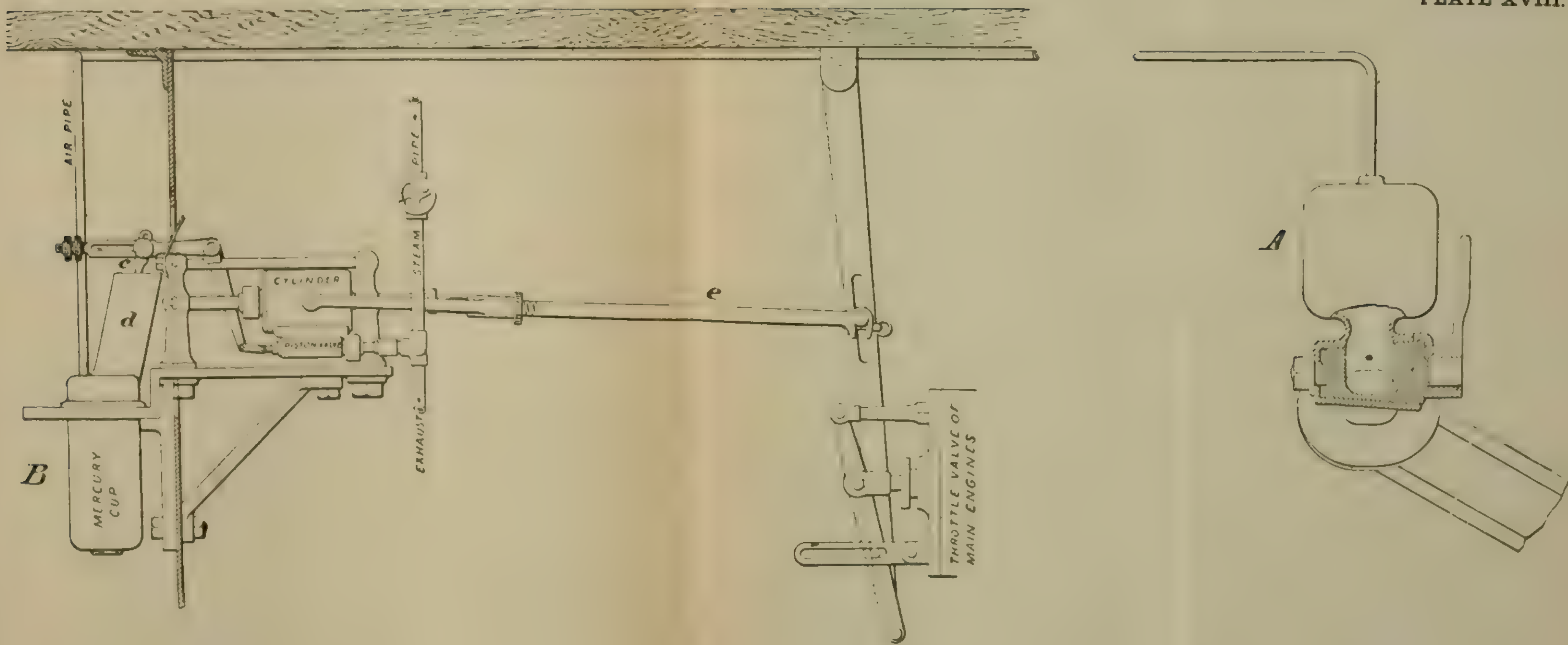
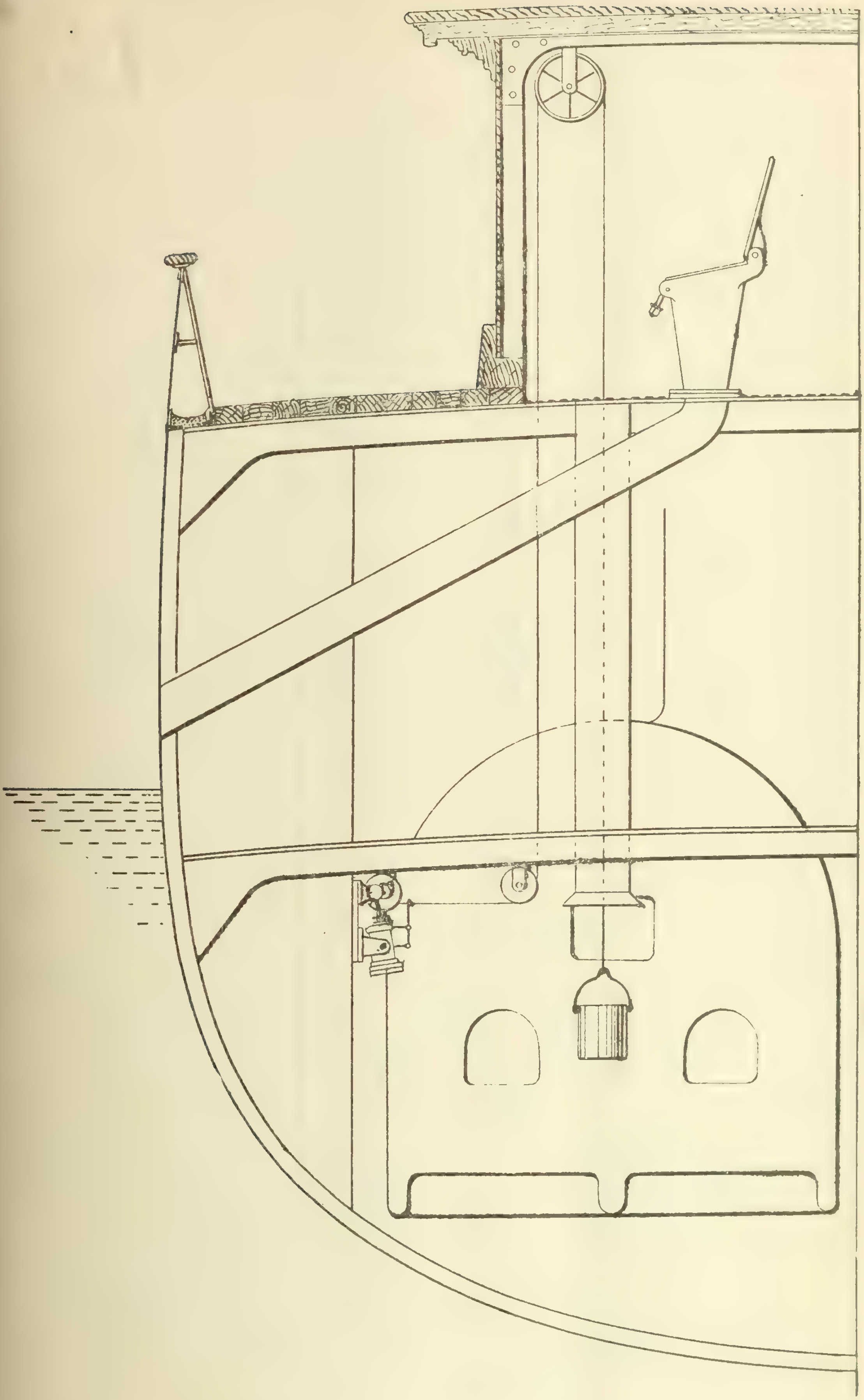
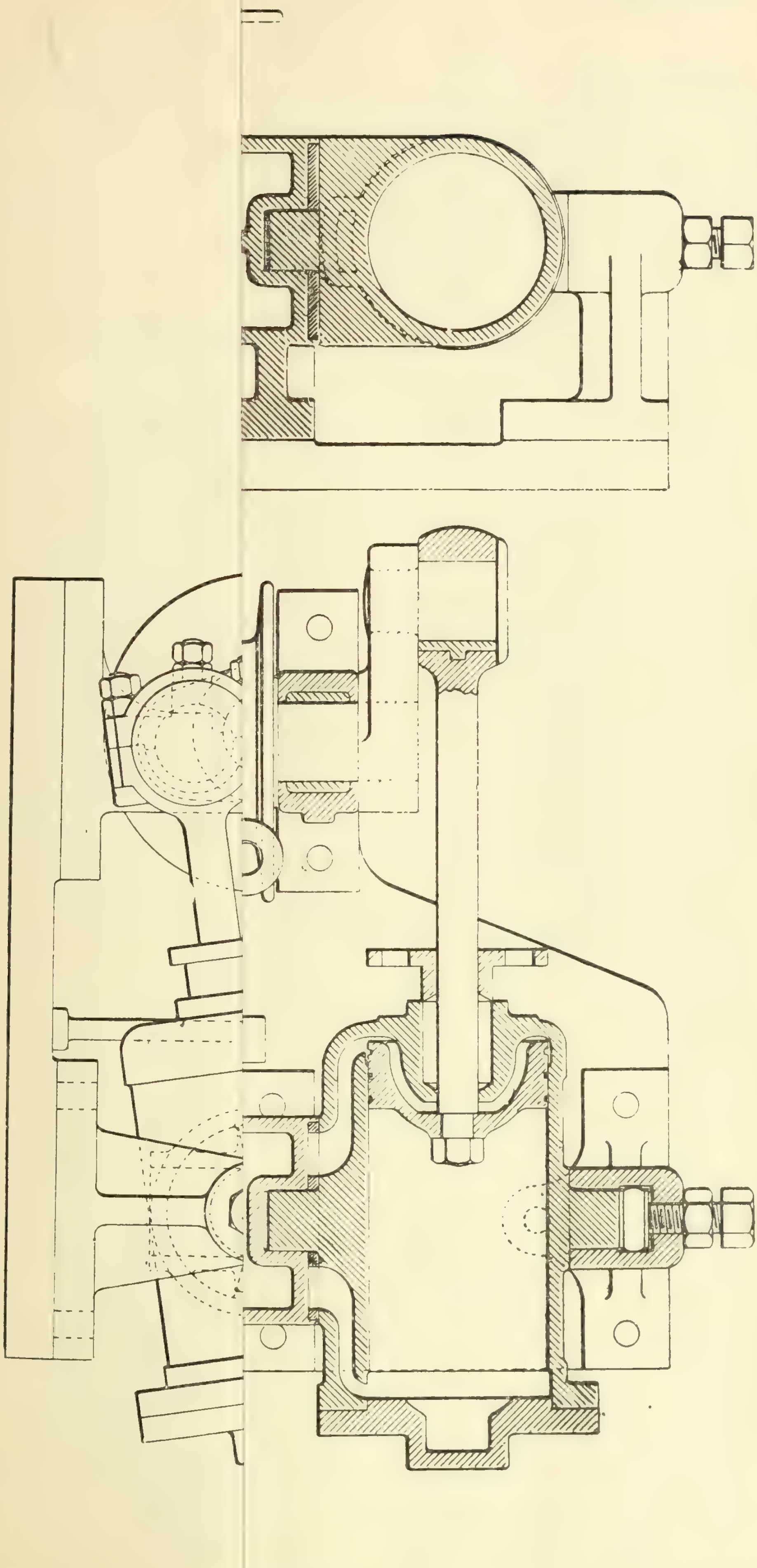
A
B
MERCURY
CUP.

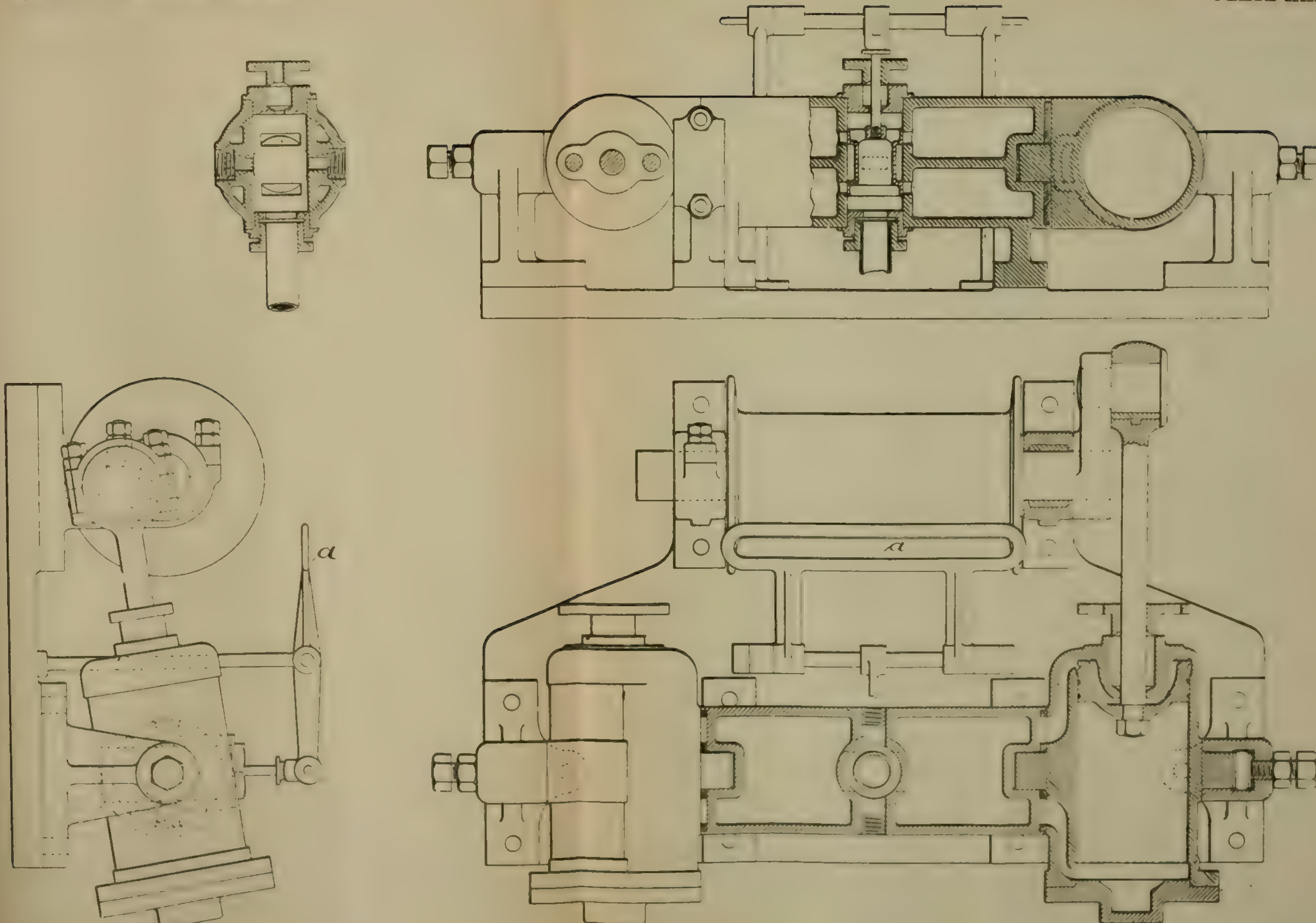


Svedberg's marine governor.

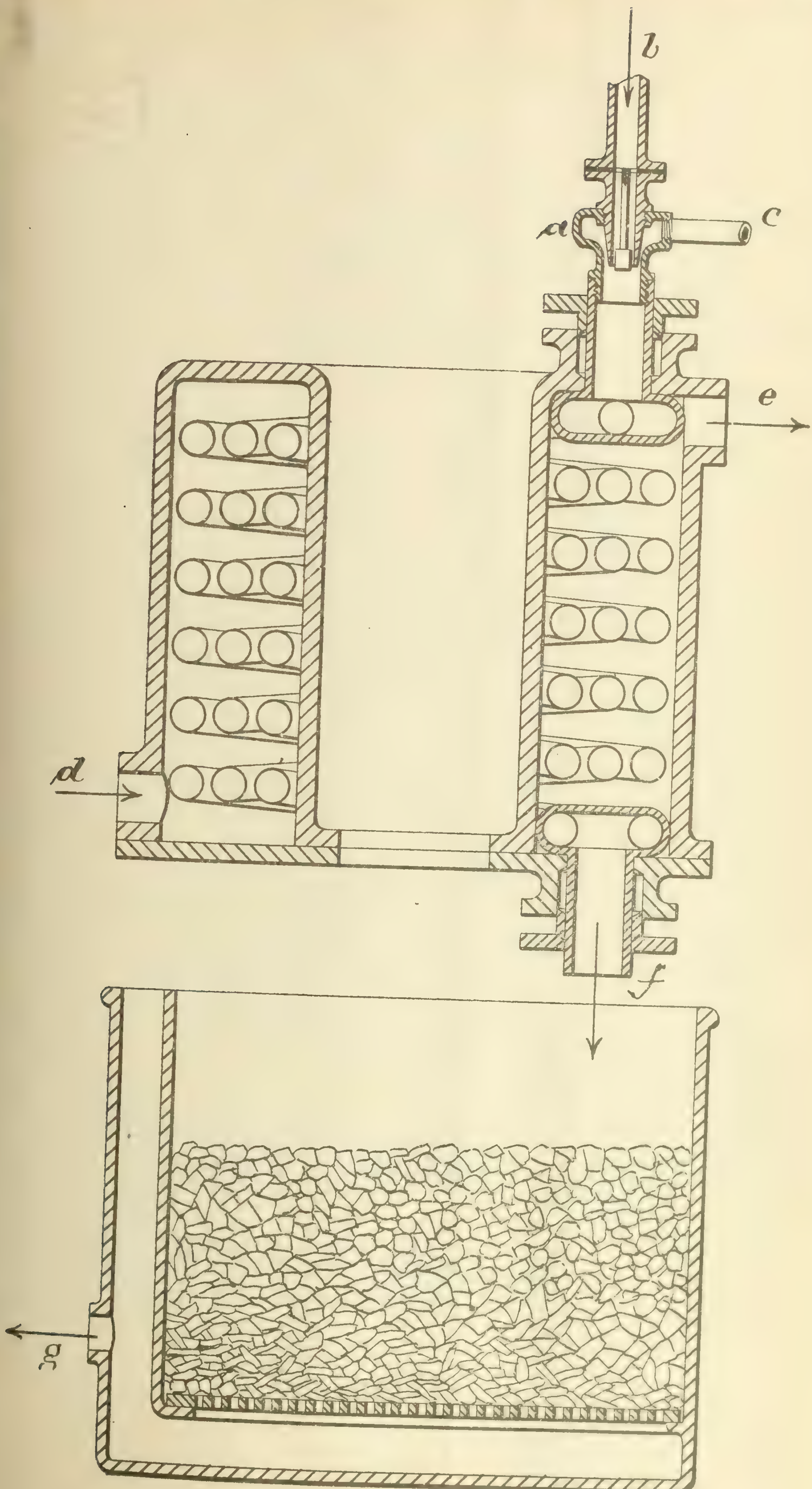


Ash elevator and shute.



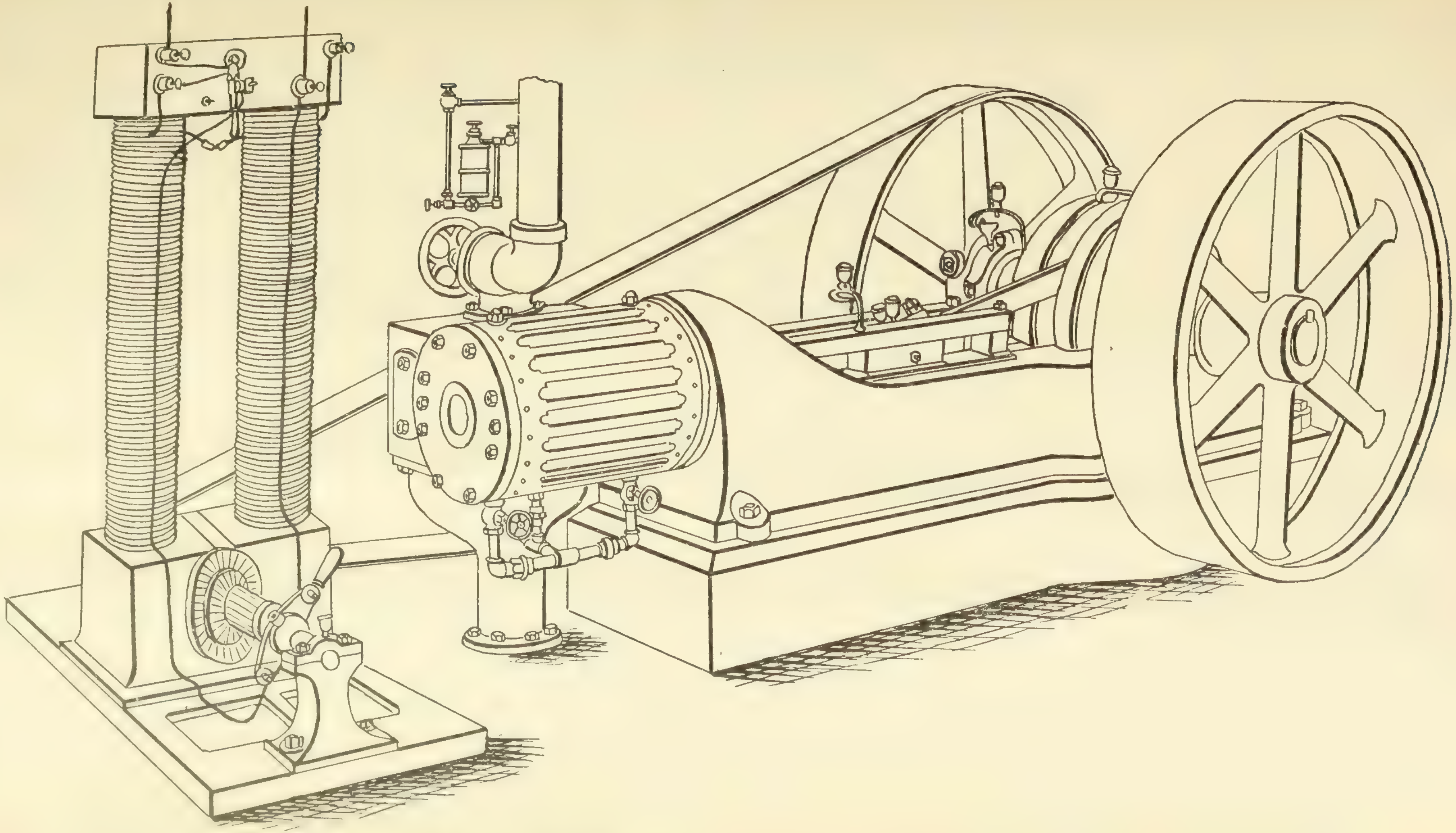


Ash-hoisting engine.

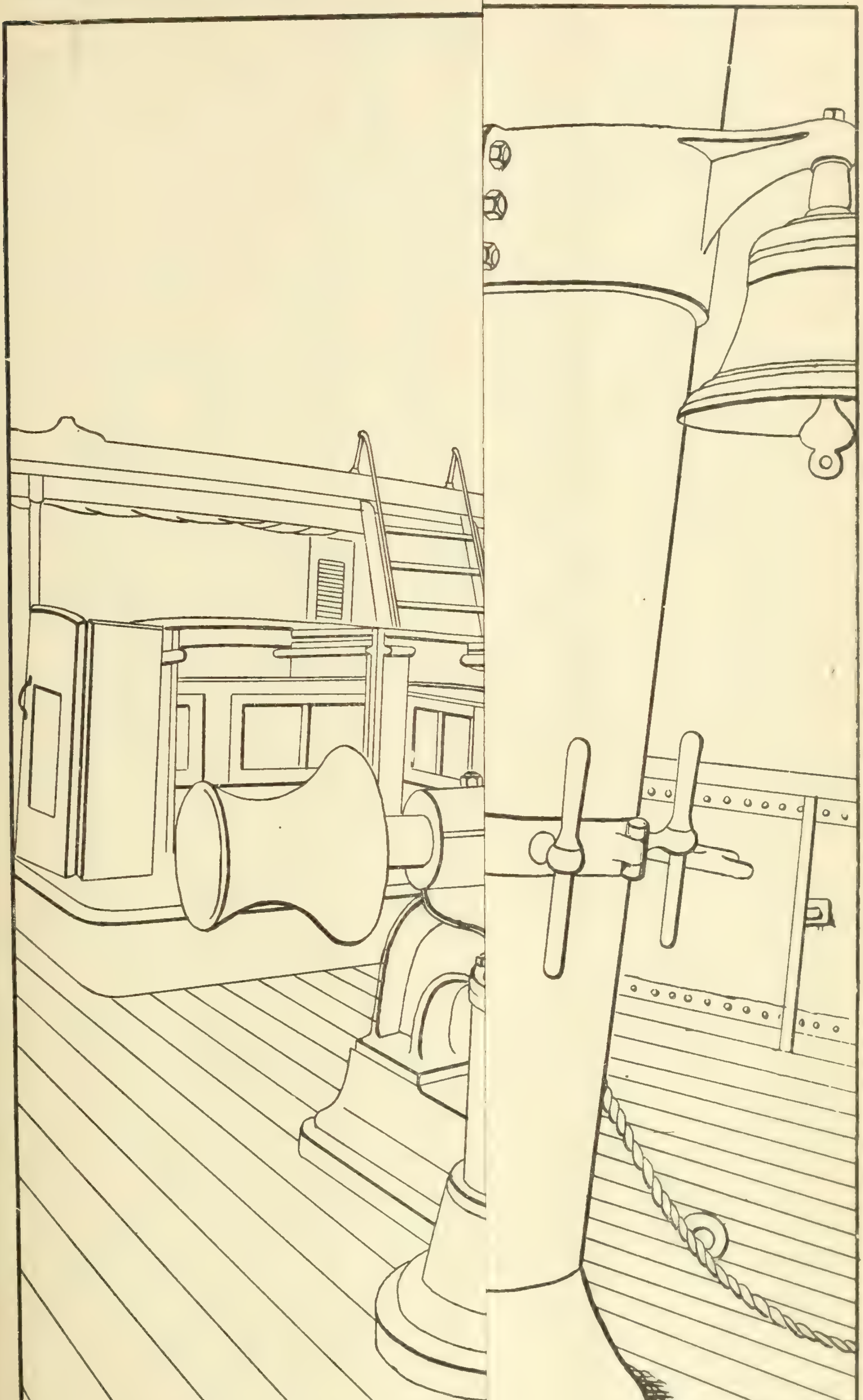


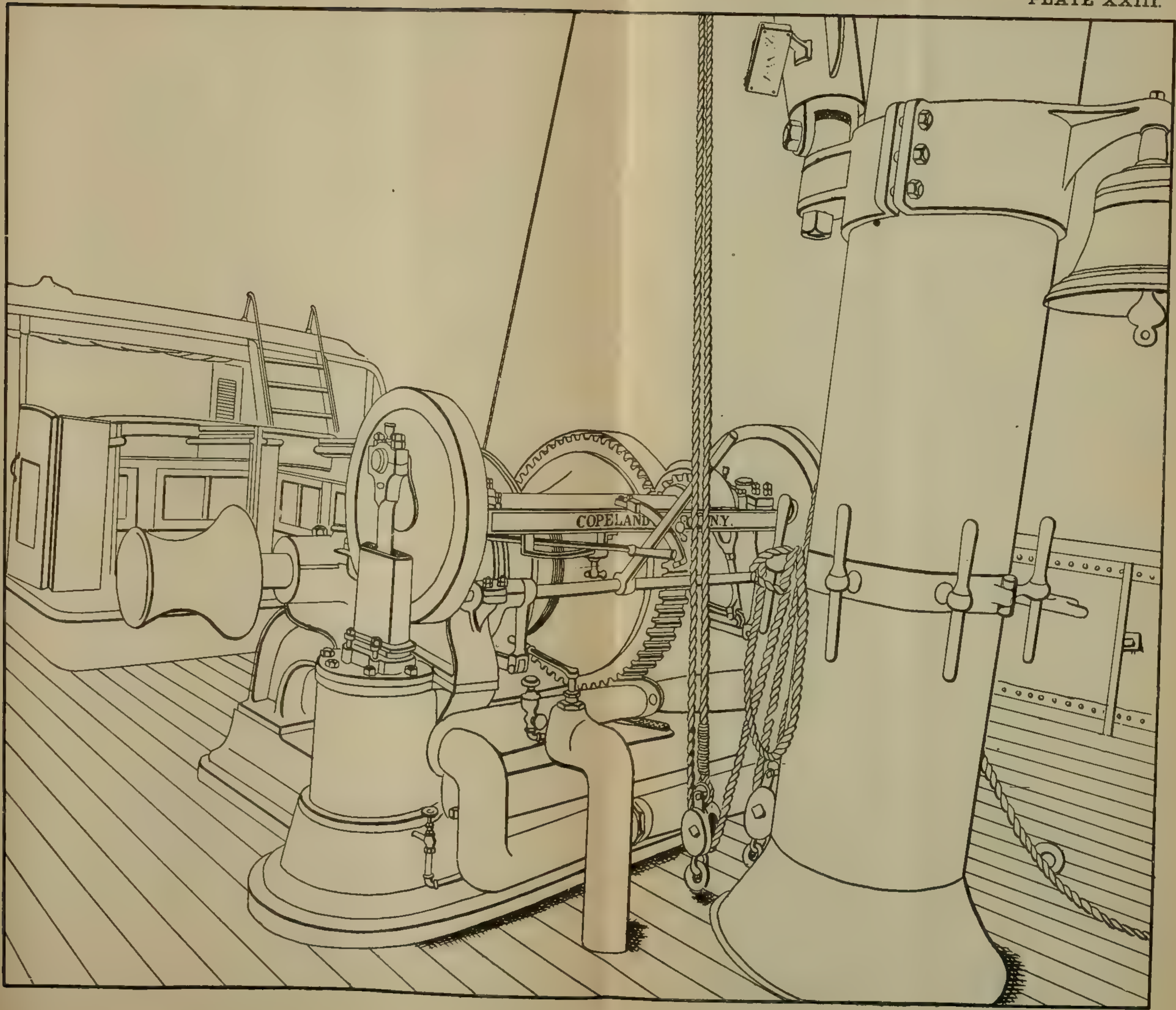
Fresh water distiller.

PLATE XXII.

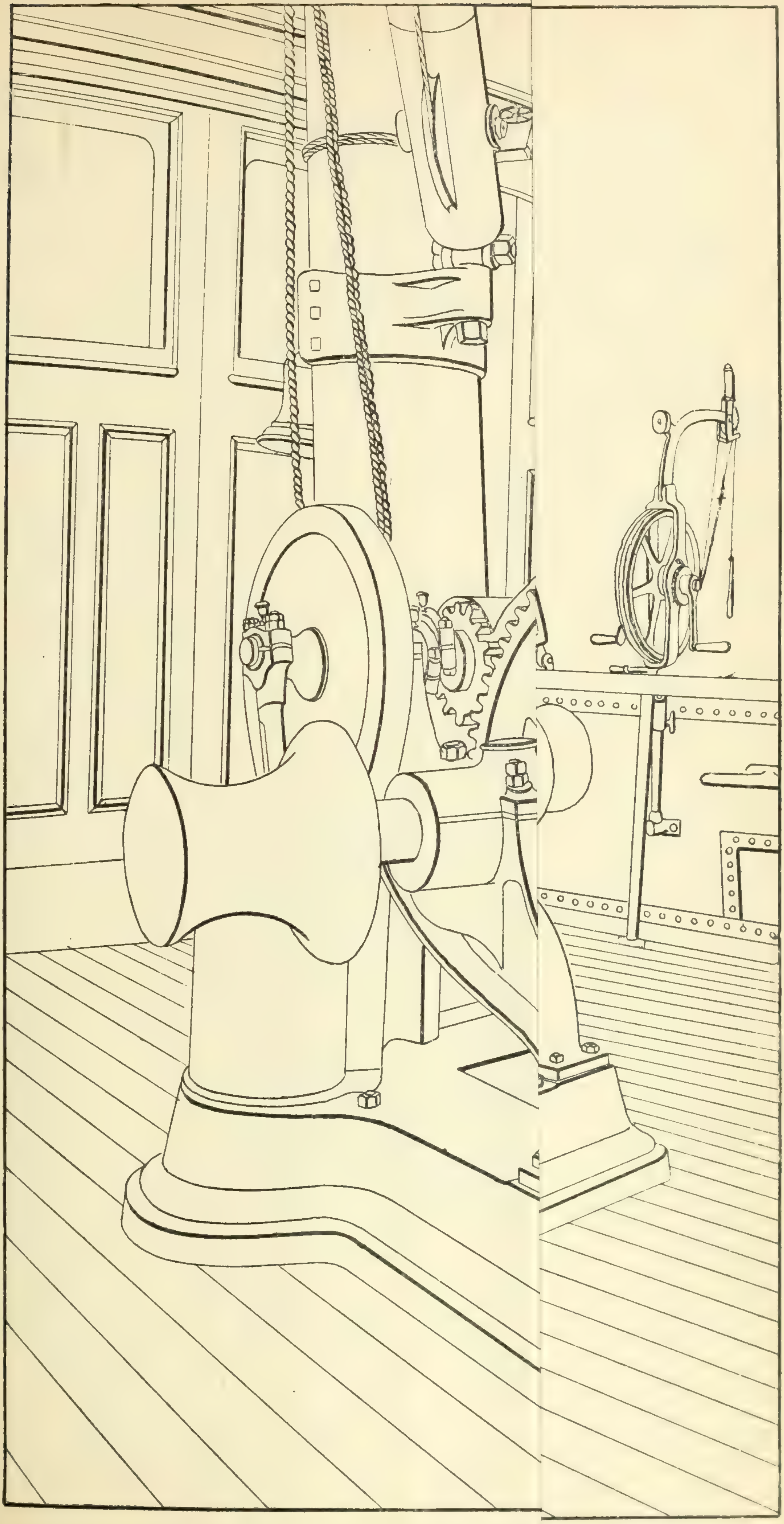


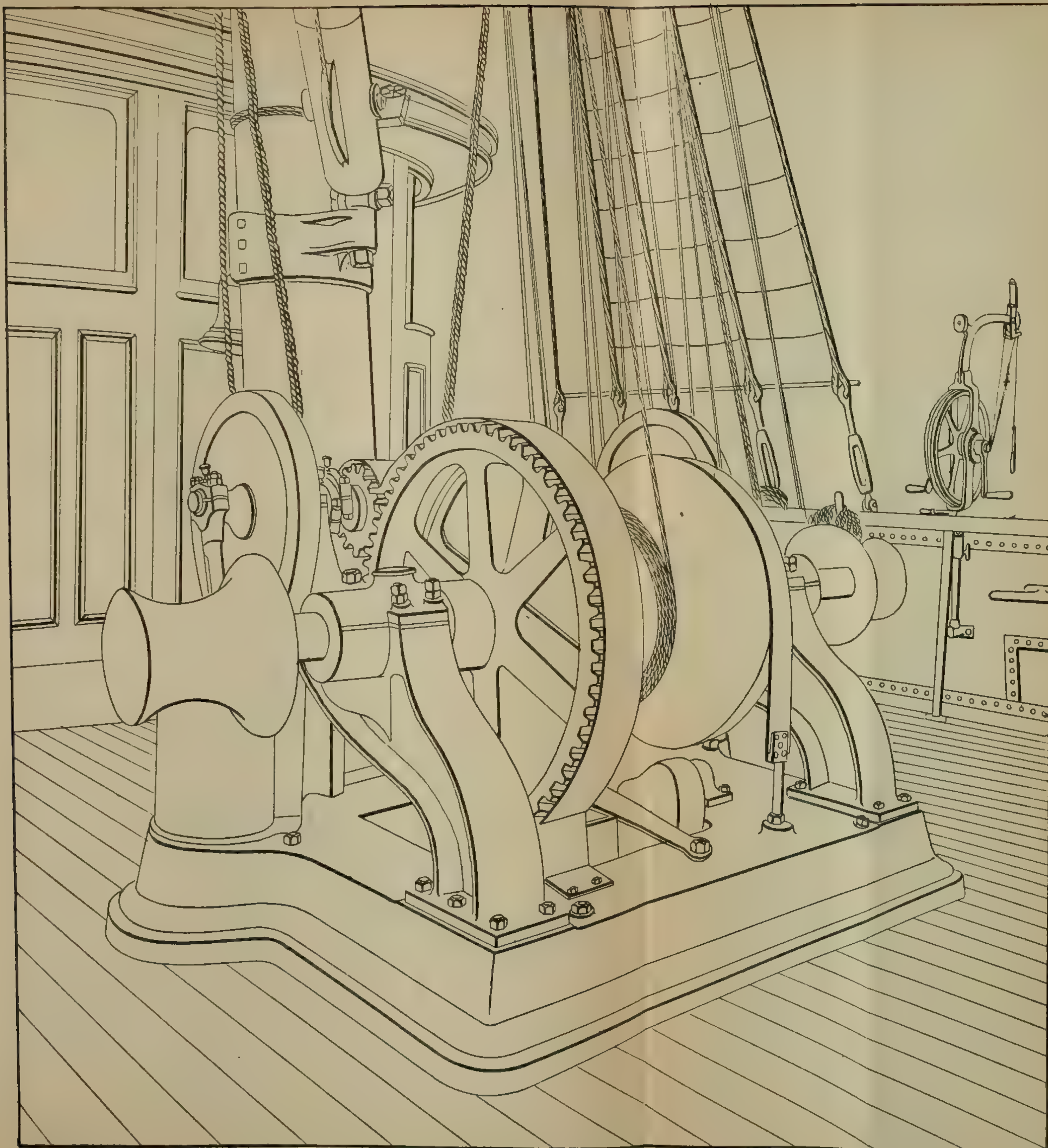
Edison dynamo and Armington & Sims engine.





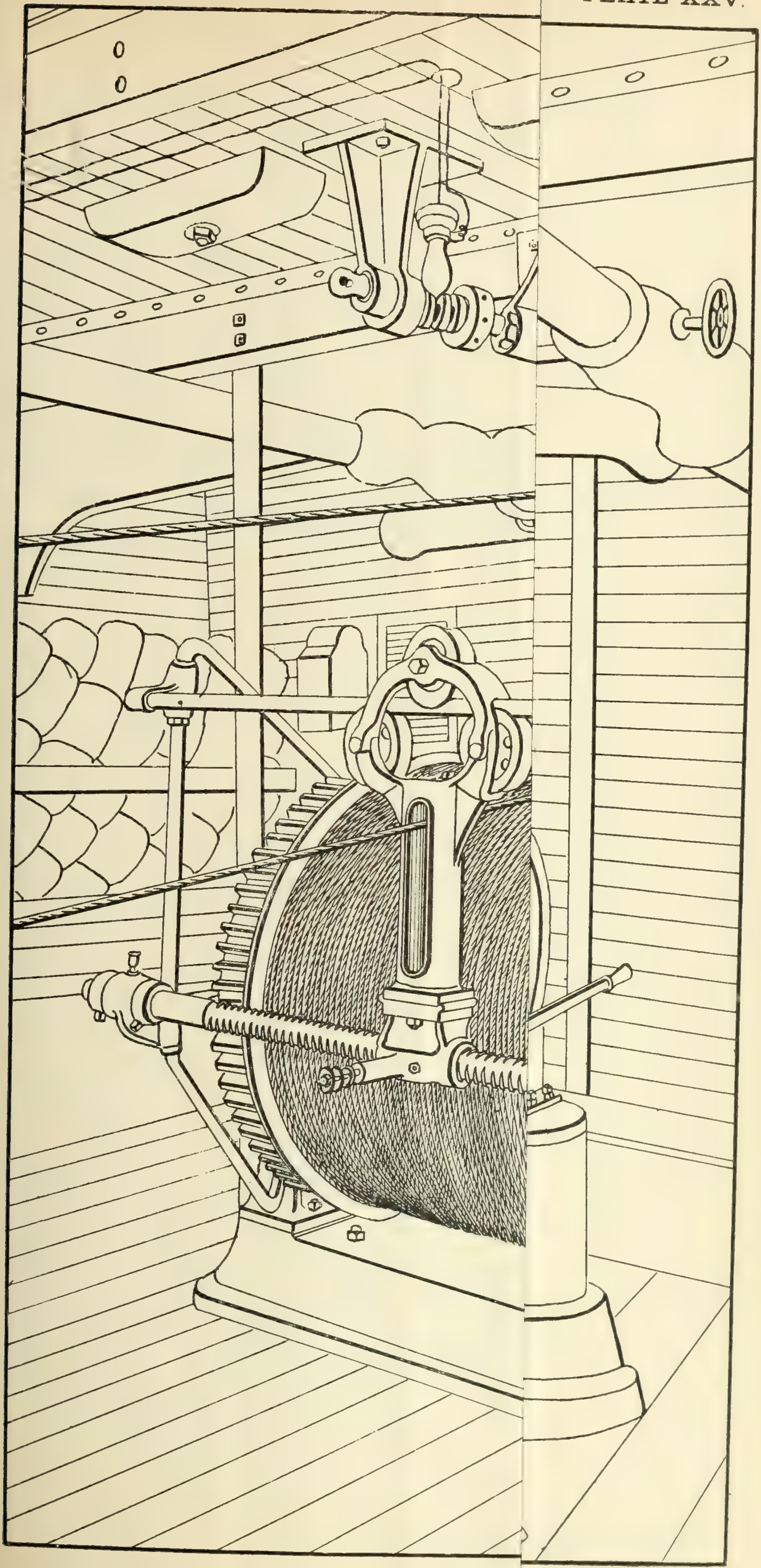
Dredging engine.

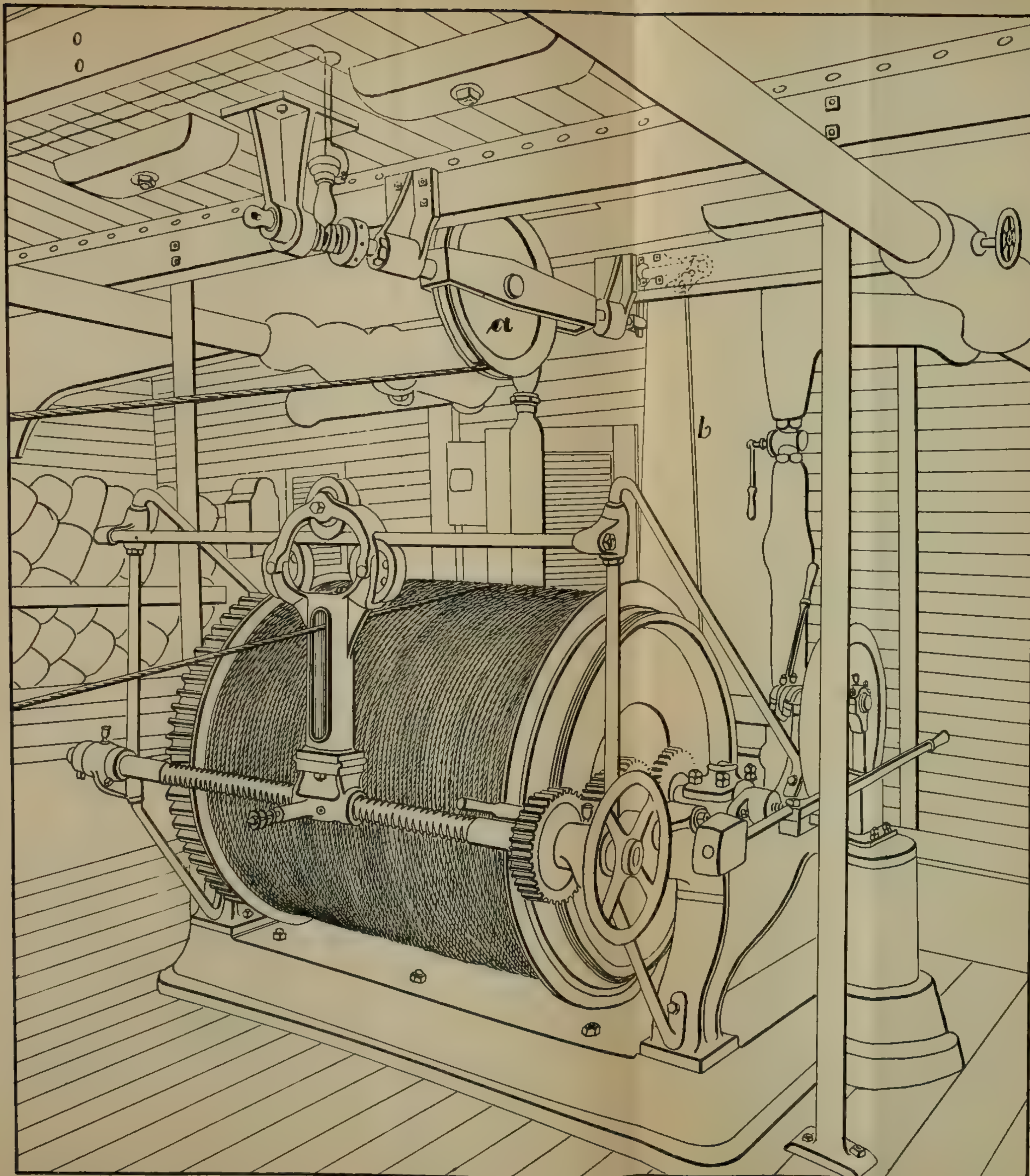




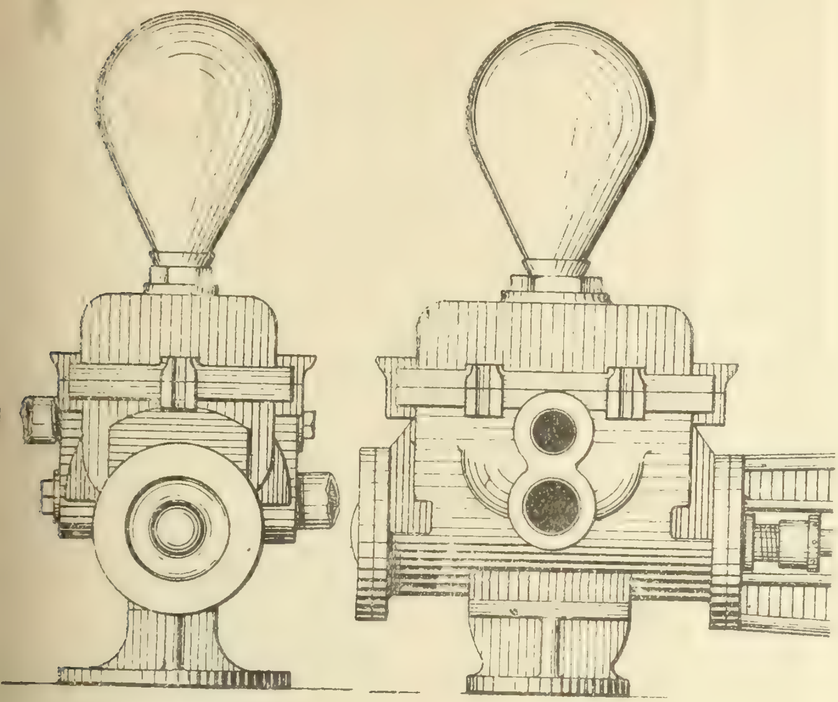
Dredging engine.

PLATE XXV.

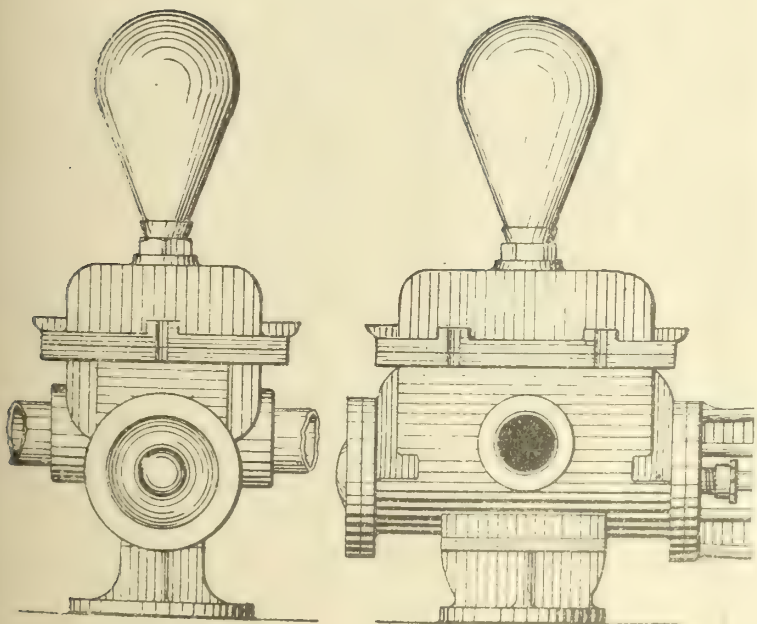




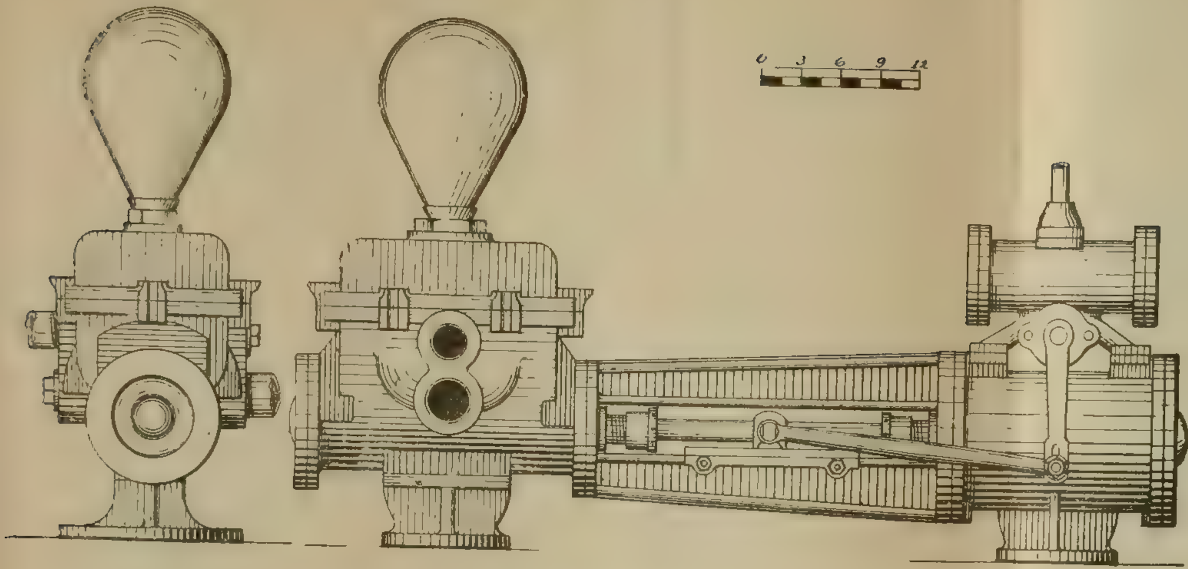
Reeling engine.



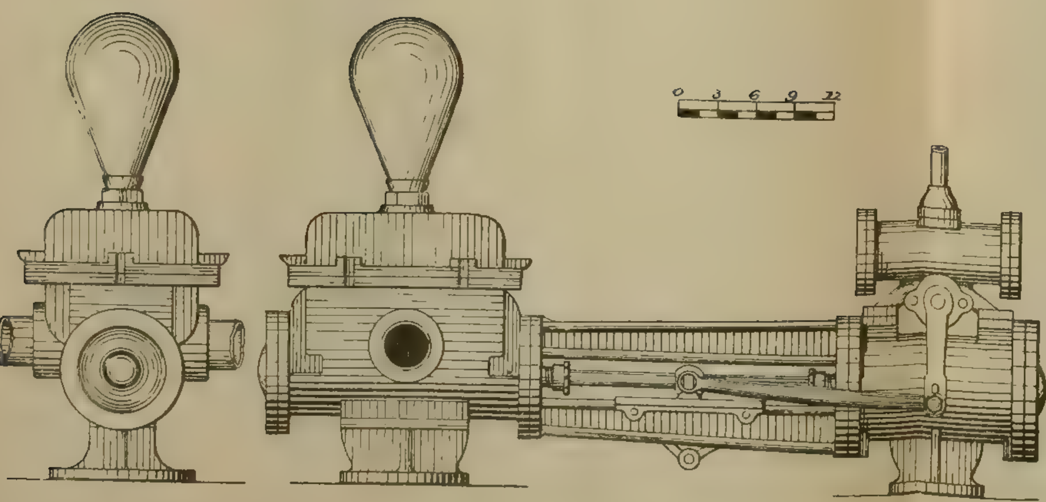
Boiler feed or fire



Hydrant pu

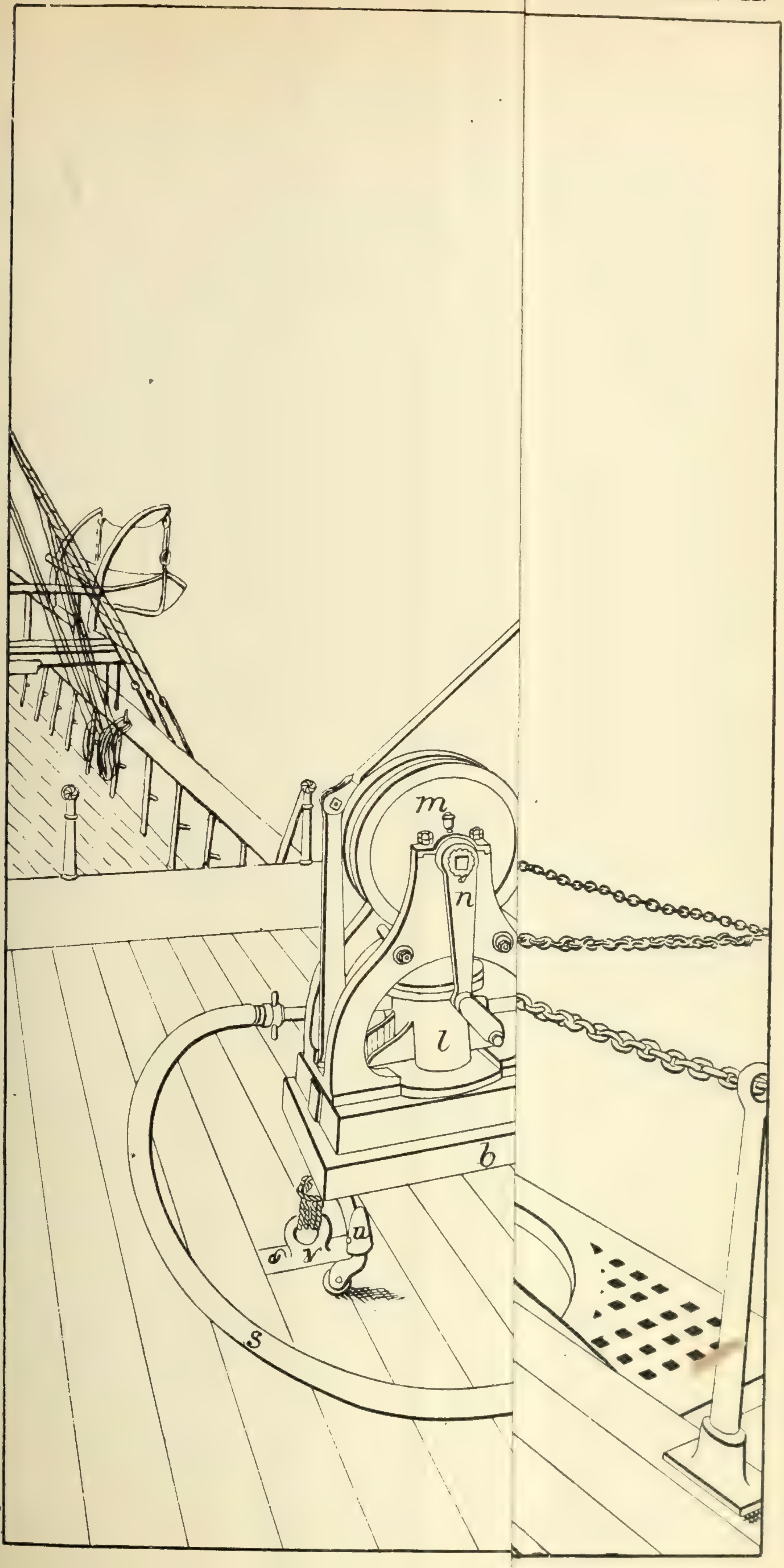


Boiler feed or fire pump.

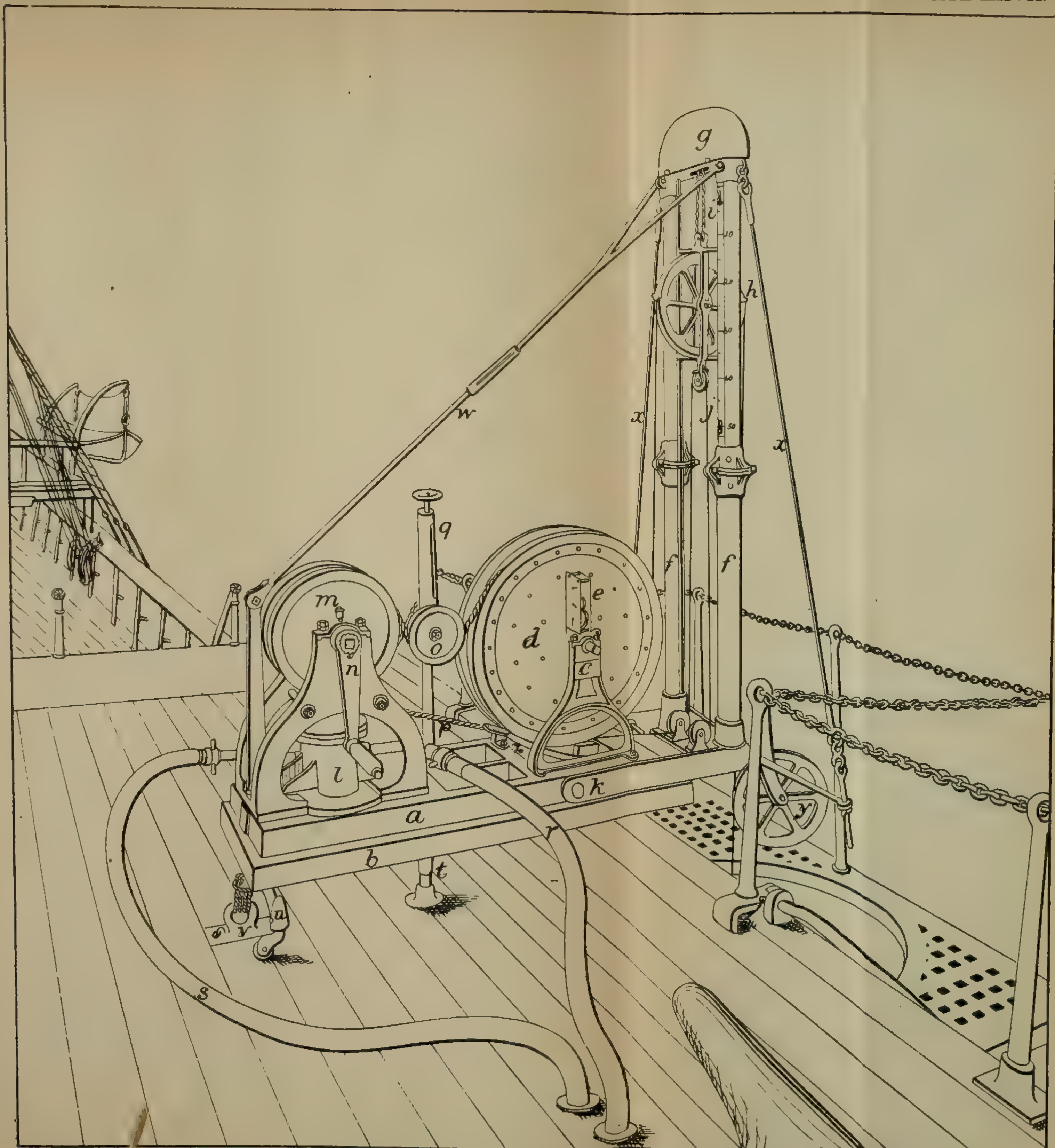


Hydrant pump.

PLATE XXVII.

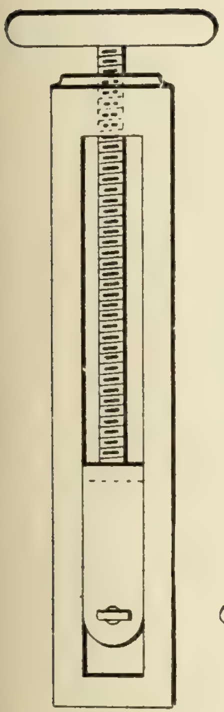


Sigbee's mac



Sigbee's machine for sounding with wire, rigged for reeling in.

PLATE XXVIII.



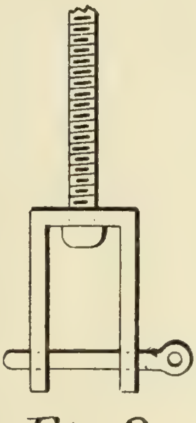
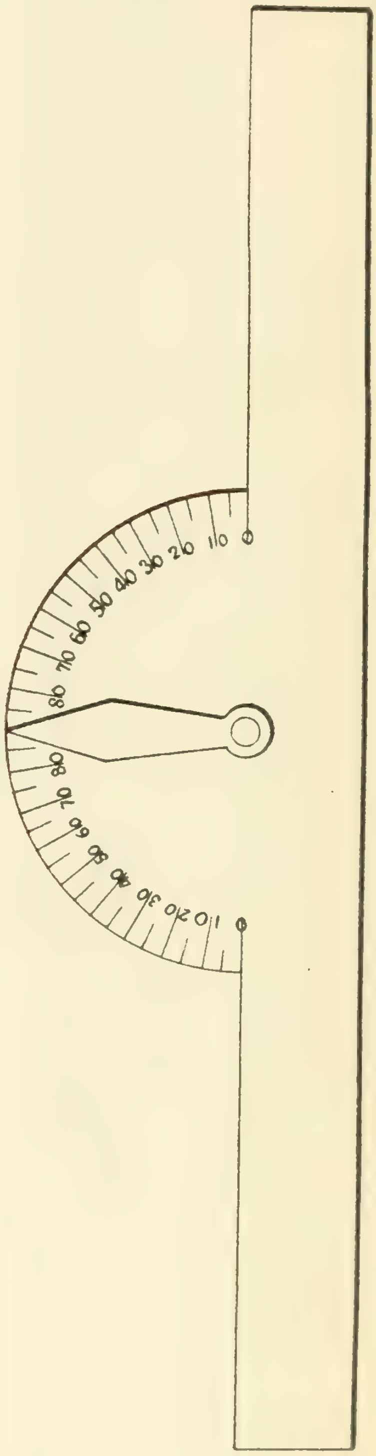


Fig.2

Fig. 1



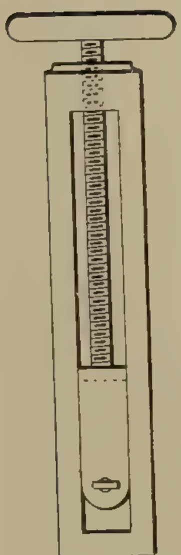


Fig. 1

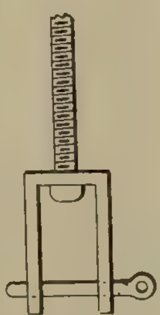


Fig. 2

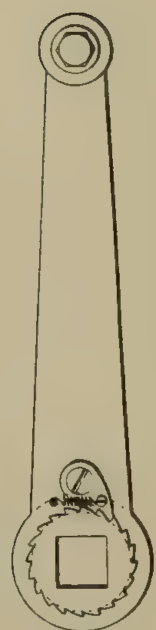


Fig. 1

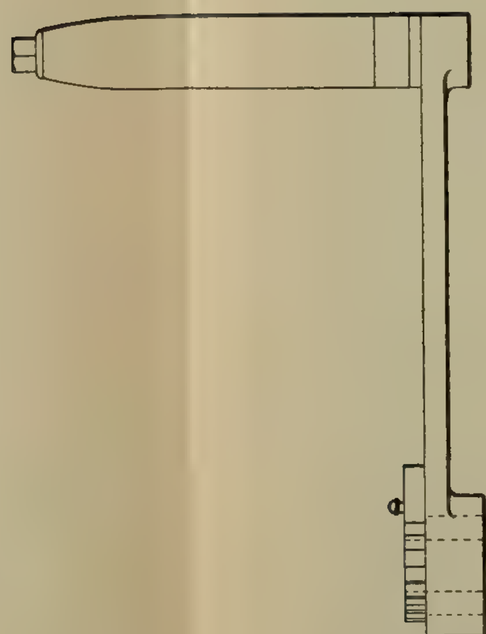
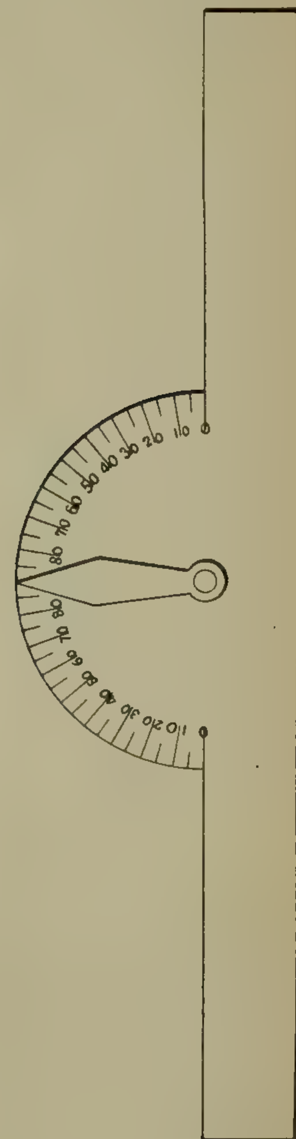
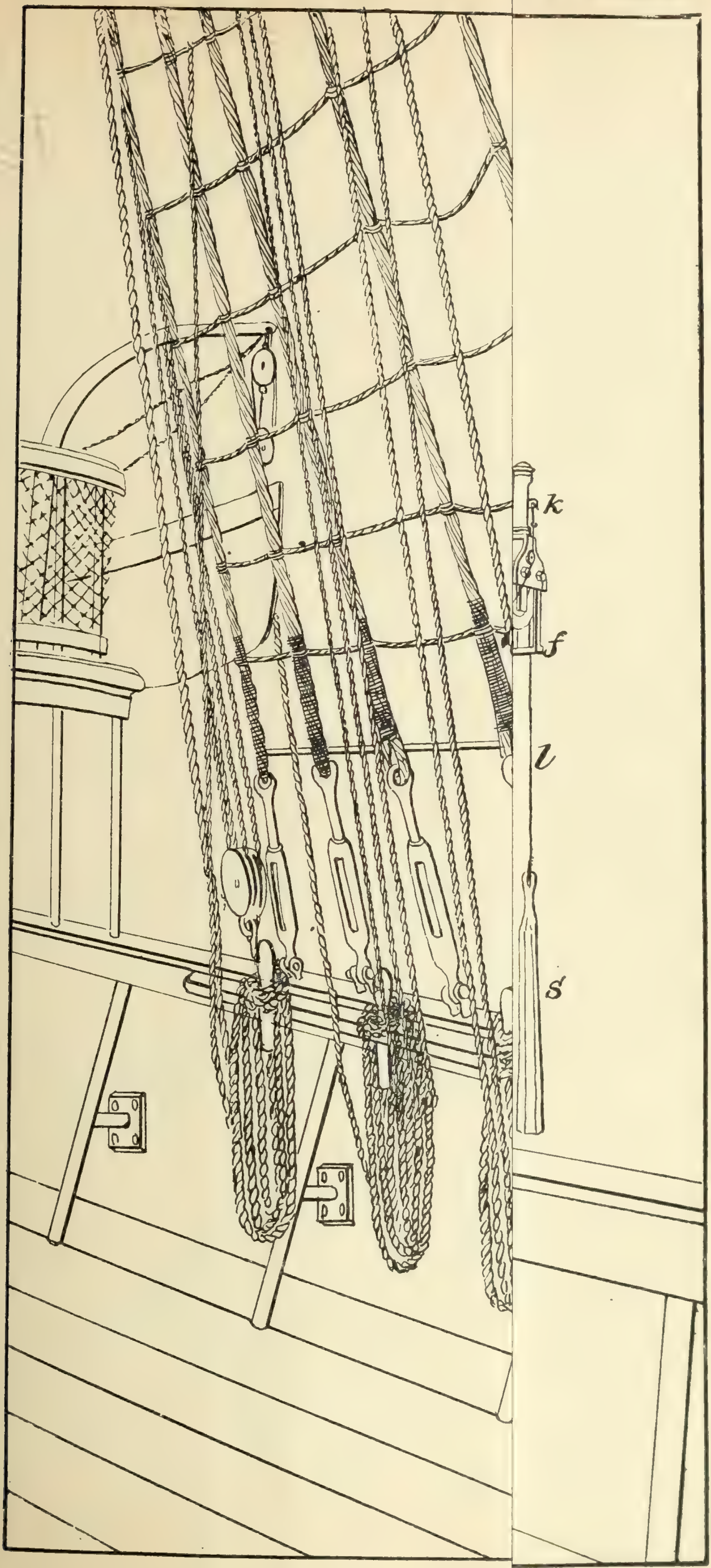


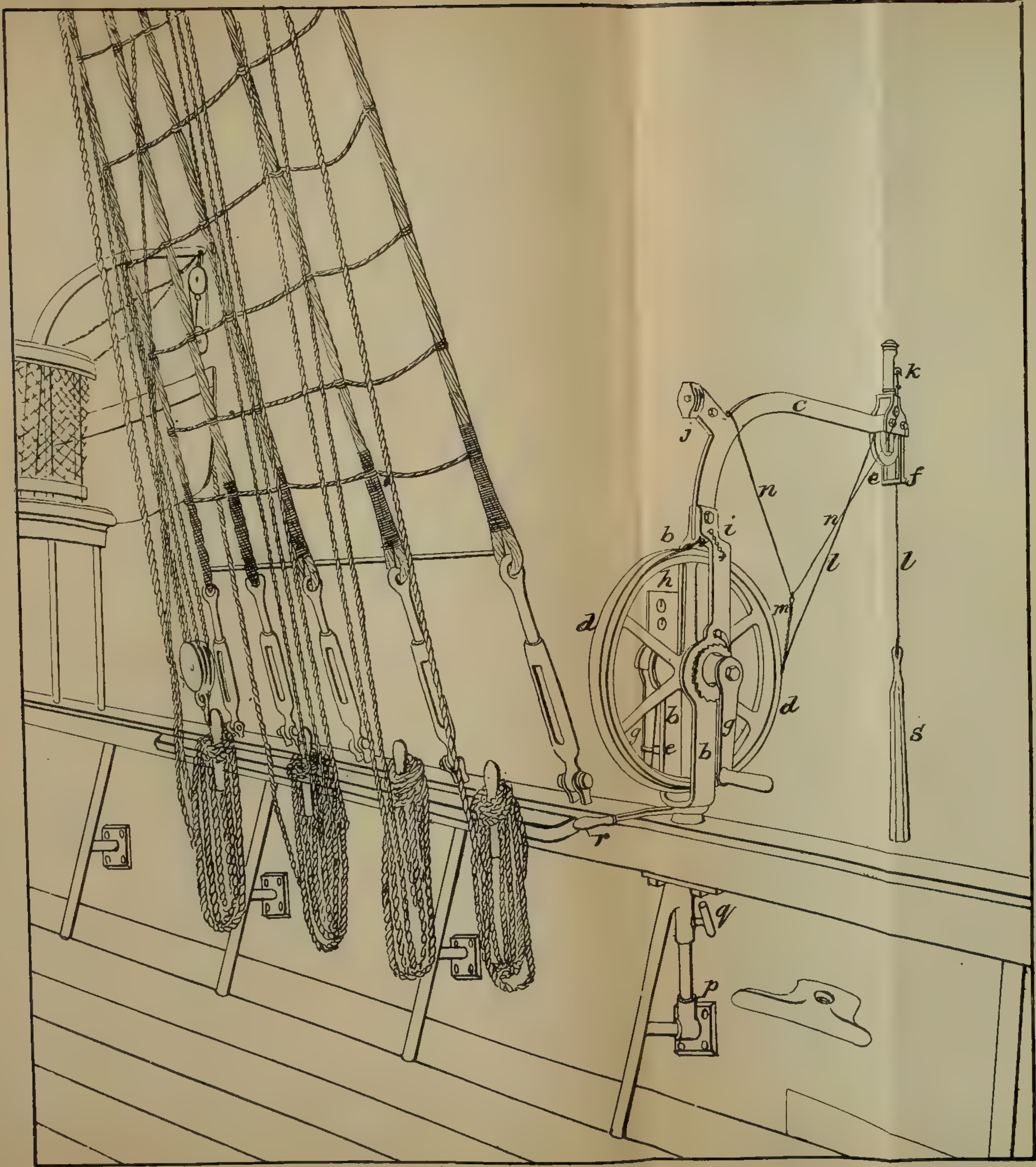
Fig. 2.



Belt-tightener, ratchet-crank, and dredging quadrant.

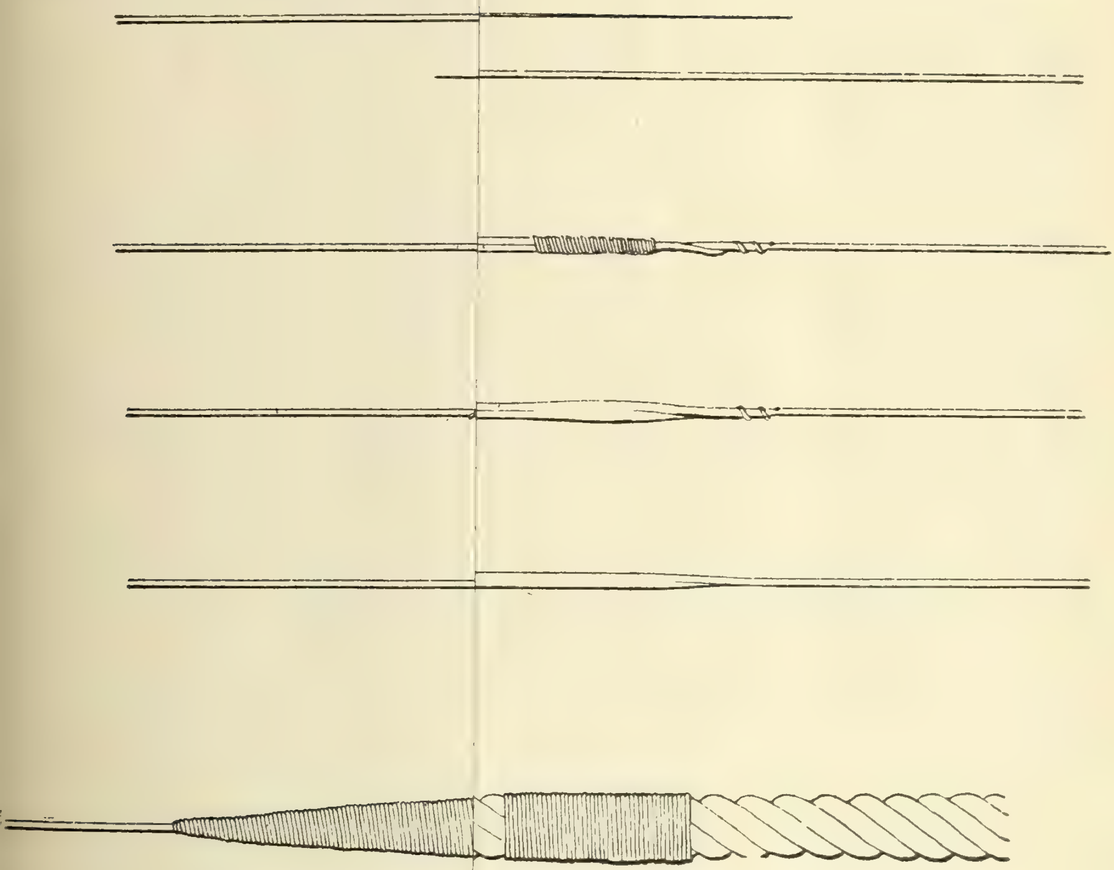
PLATE XXIX.





Tanner sounding machine.

PLATE XXX.



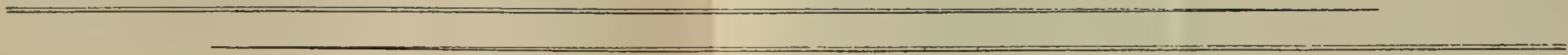


Fig. 1.

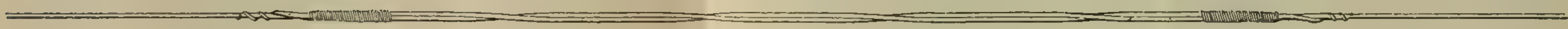


Fig. 2.

Fig. 3.

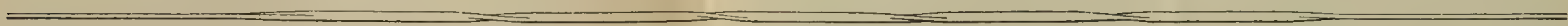


Fig. 4.

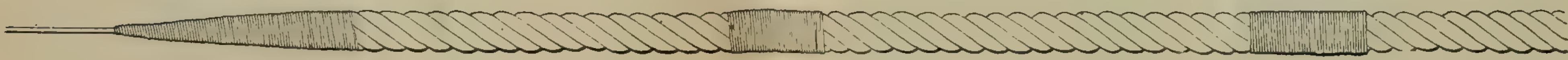
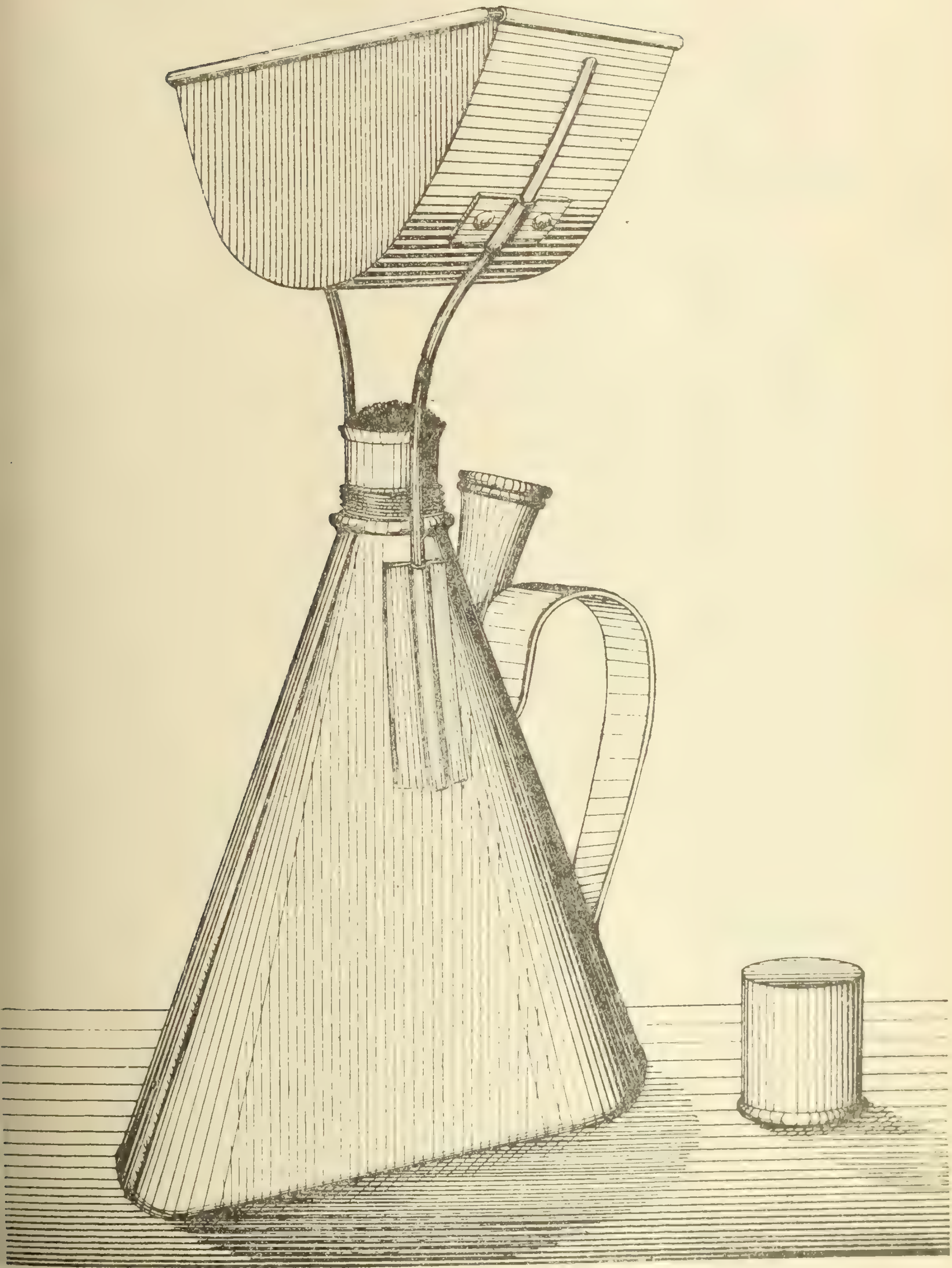


Fig. 5.

Wire splices.



Soldering lamp.

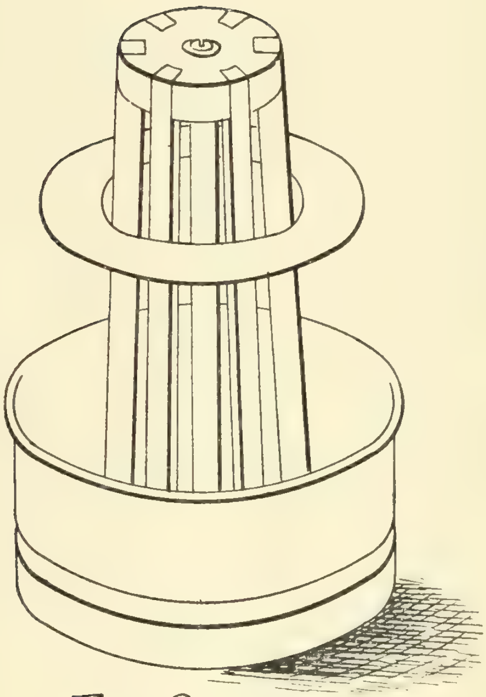
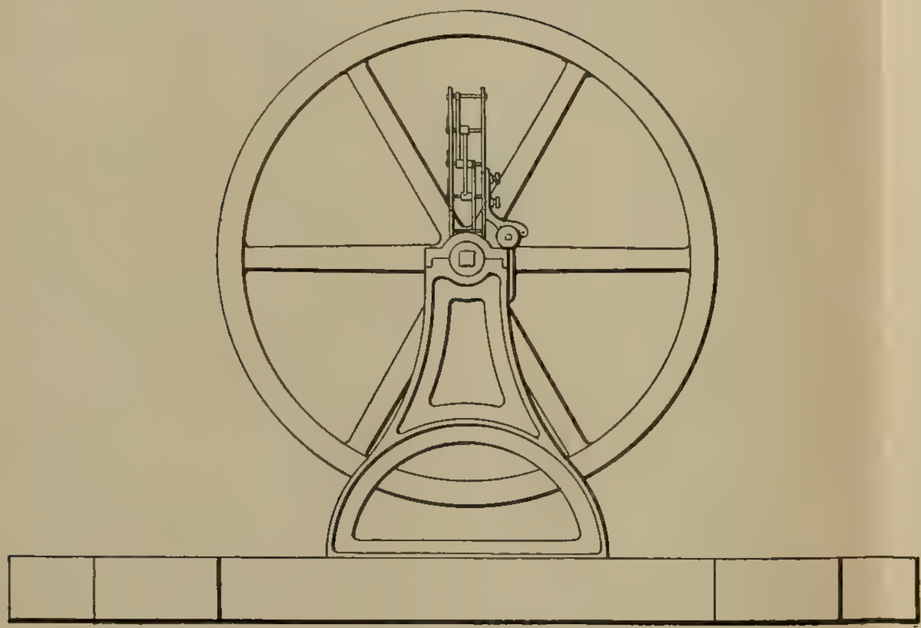


Fig. 2.

Blade.



Measuring reel.

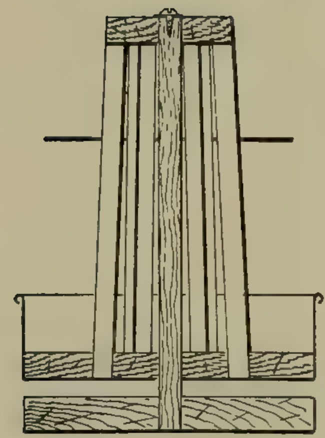


Fig. 1.

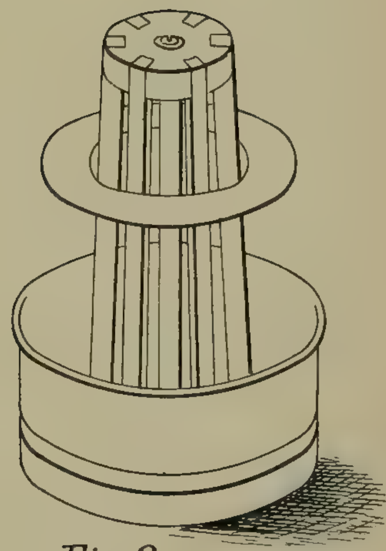


Fig. 2.

Blade.

PLATE XXXIII

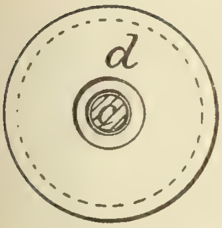
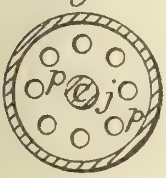
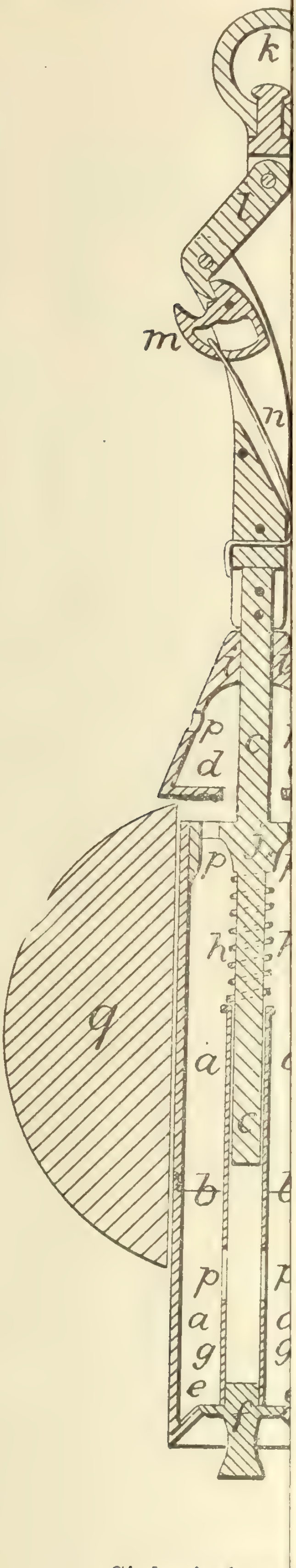


Fig. 5.





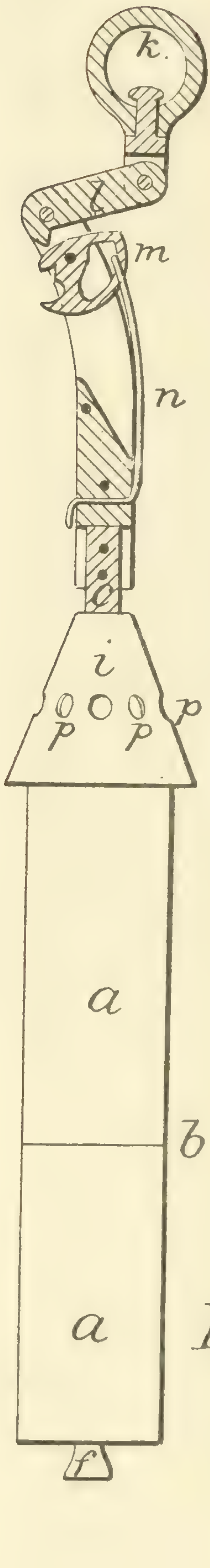
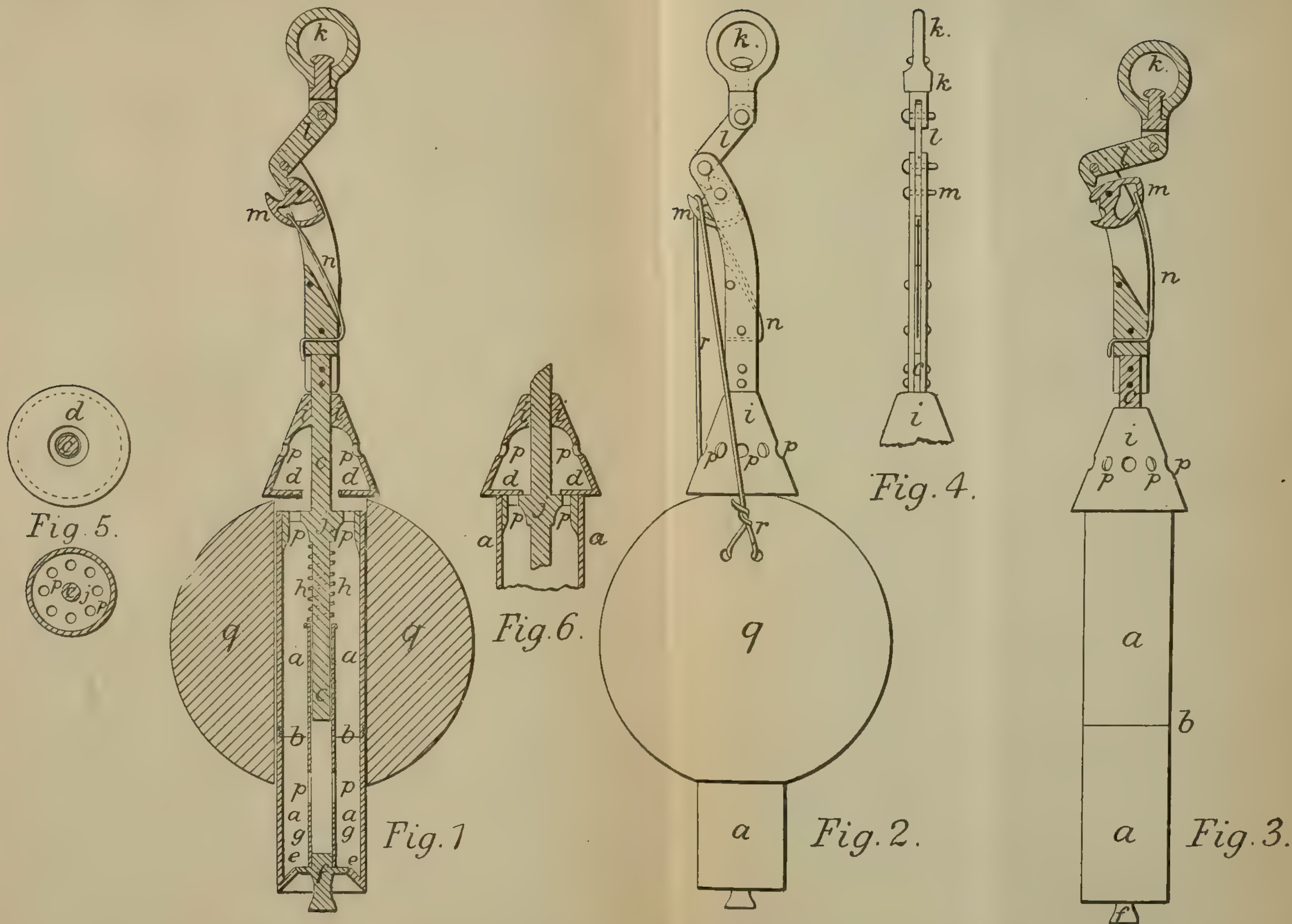


Fig. 3.

Sigbee's detacher No. 2.



Sigbee's detacher, used in connection with a modification of Captain Belknap's sounding cylinder No. 2.

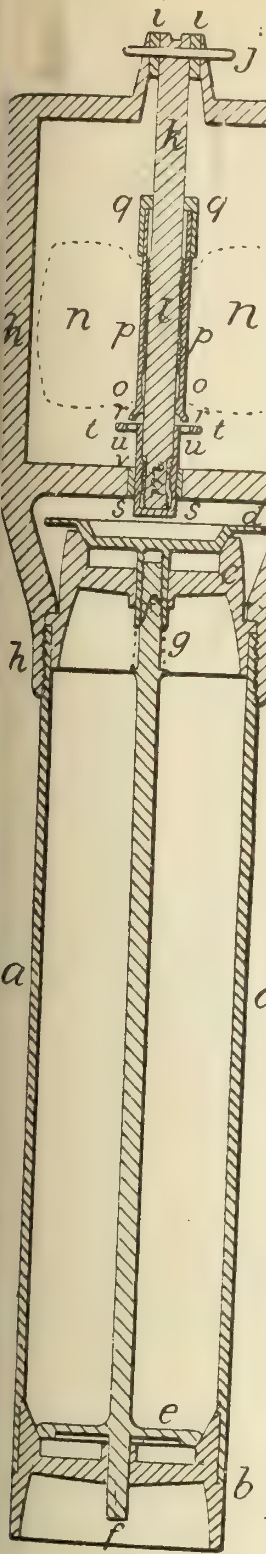


Fig. 1

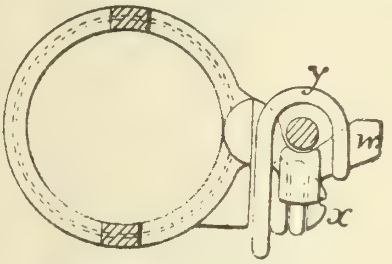


Fig. 4

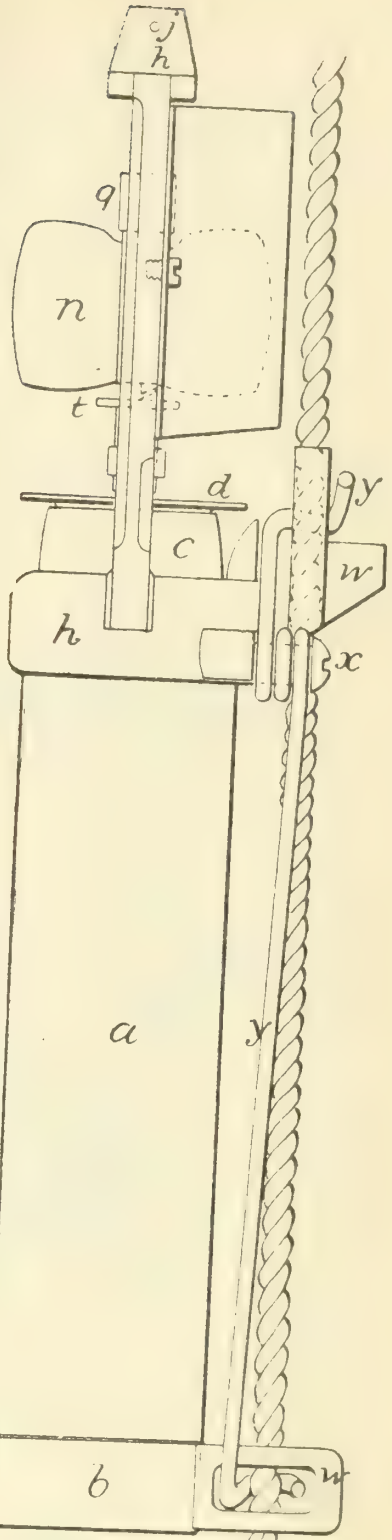


Fig. 2.

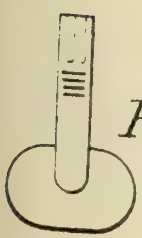
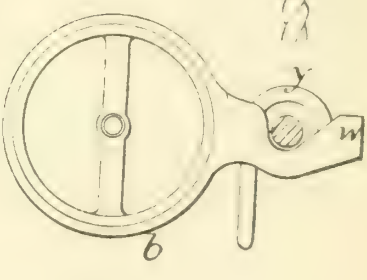
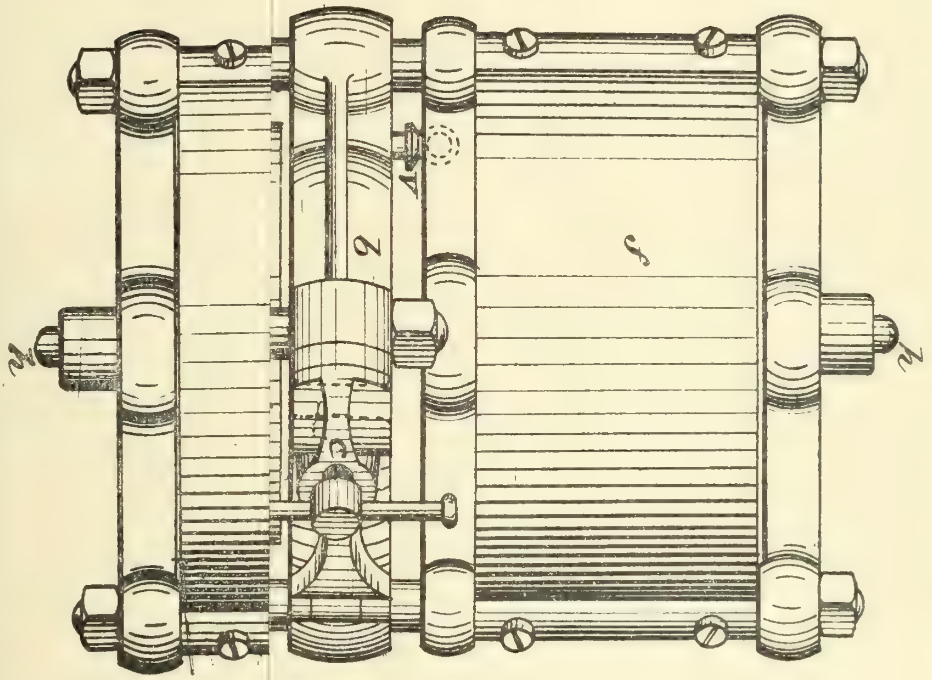


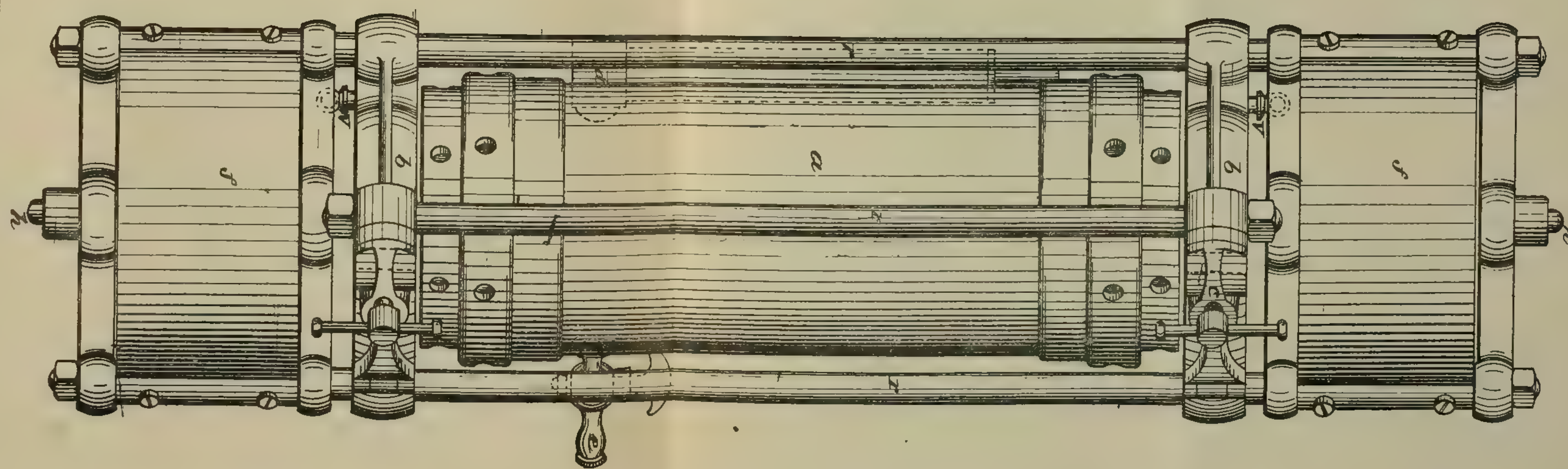
Fig. 5

Fig. 3

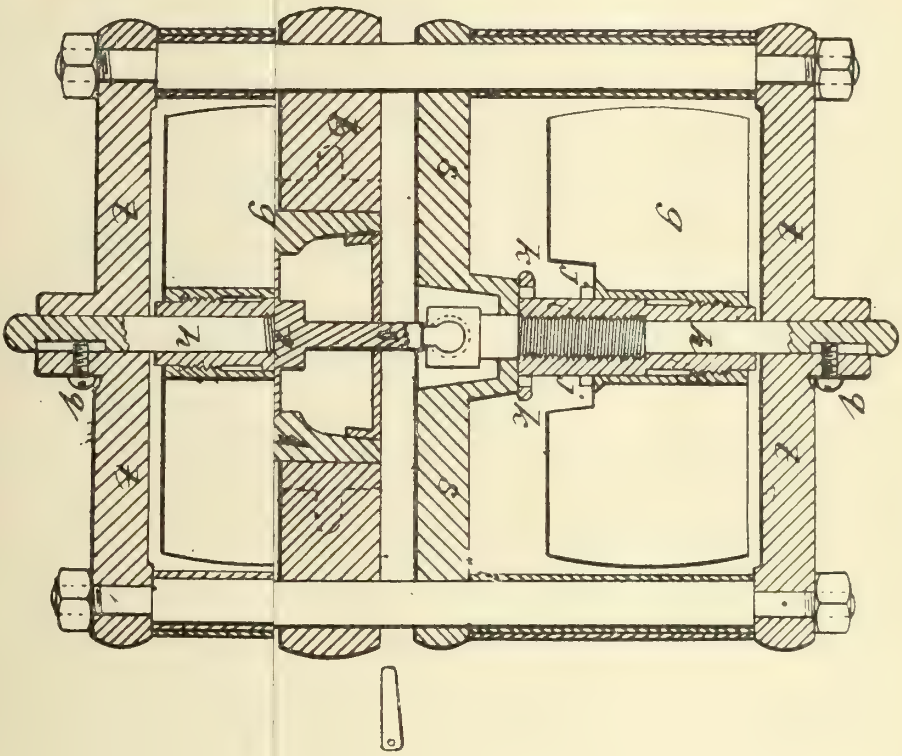


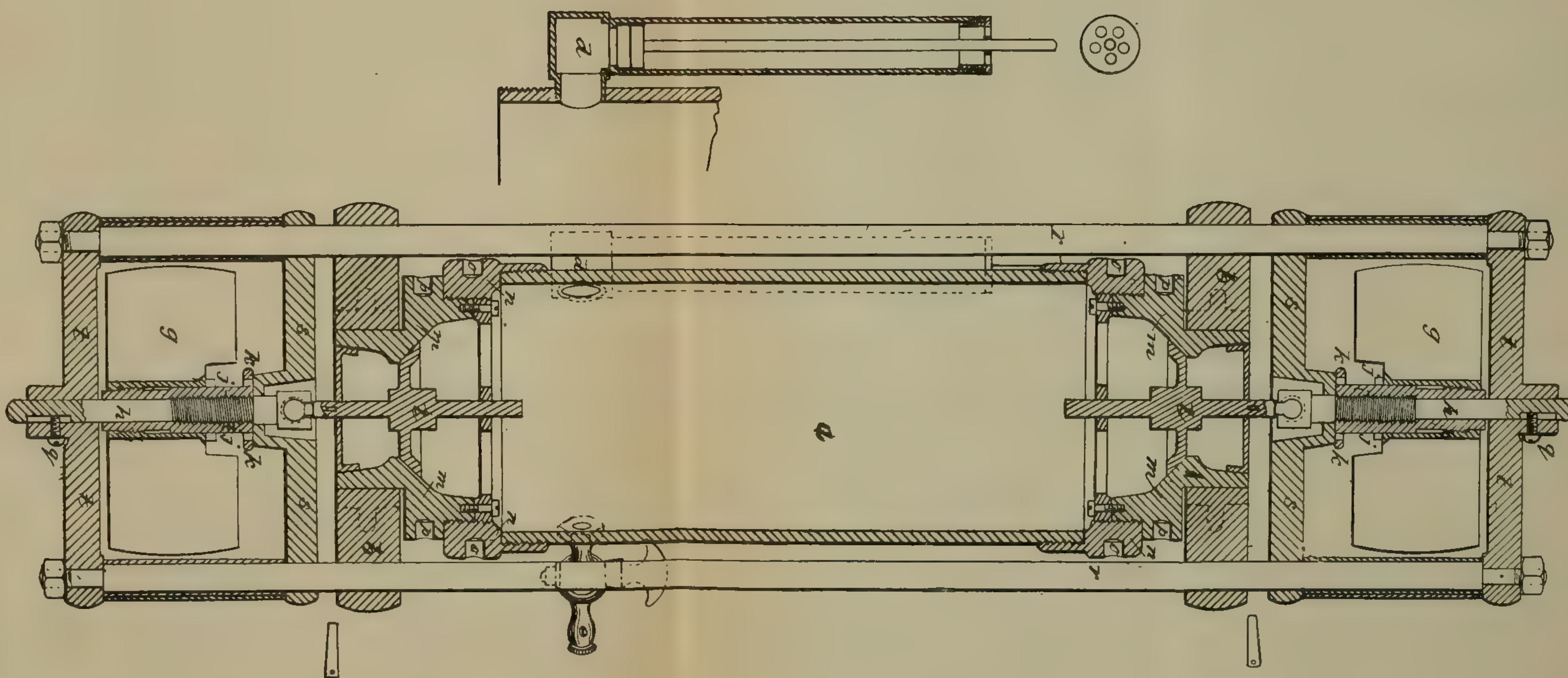
Sigsbee's water-specimen cup.





Improved water-bottle.





Improved water-bottle, sectional elevation.

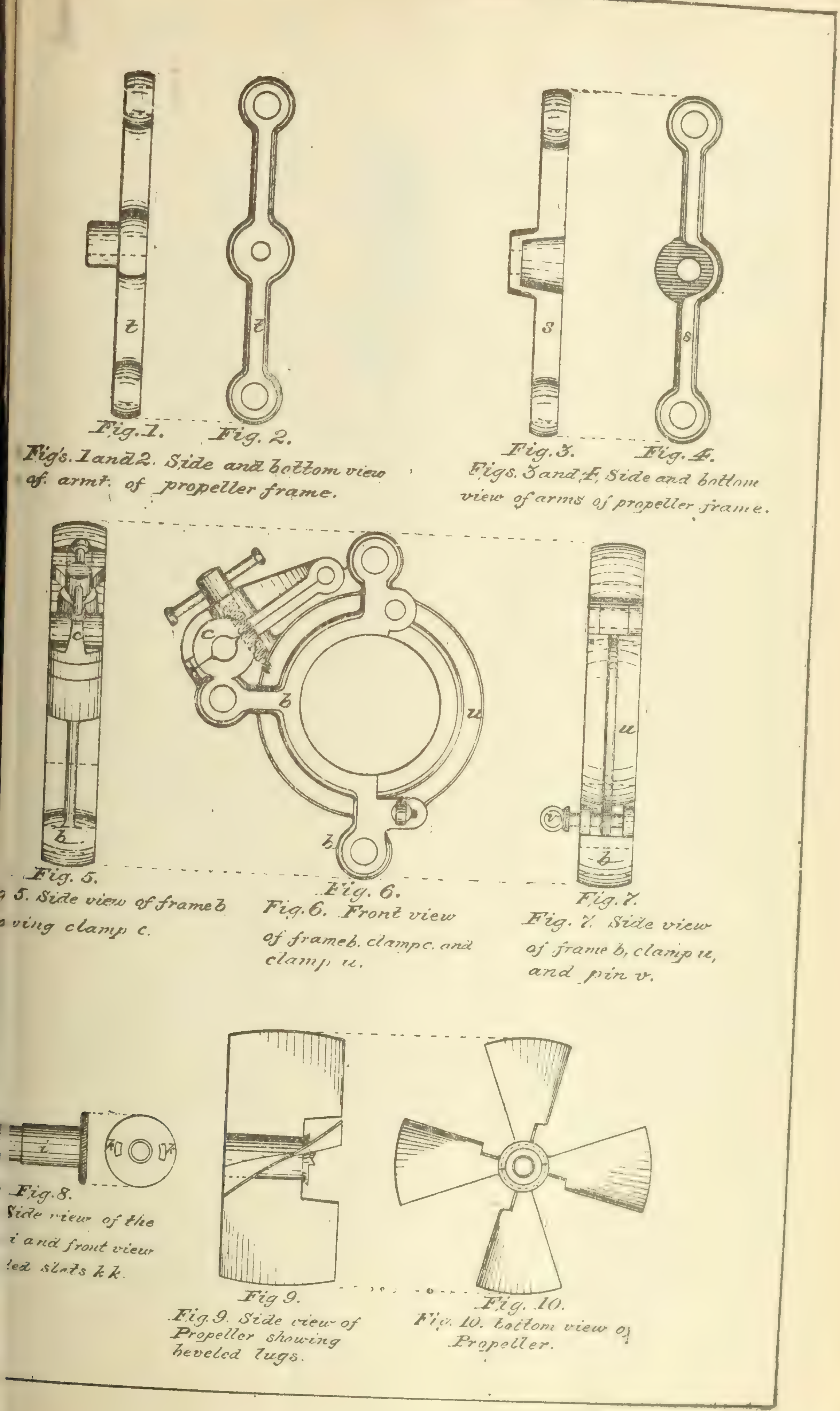


Fig. 1. Fig. 2.

Fig's. 1 and 2. Side and bottom view of arm t. of propeller frame.

Fig. 3. Fig. 4.

Figs. 3 and 4. Side and bottom view of arms of propeller frame.

Fig. 5.

[Fig]. 5. Side view of frame b [sh]ving clamp c.

Fig. 6.

Fig. 6. Front view of frame b. clamp c. and clamp u.

Fig. 7.

Fig. 7. Side view of frame b, clamp u, and pin v.

Fig. 8.

[Fig. 8.] Side view of the [...] i and front view [...]led slots k k.

Fig. 9.

Fig. 9. Side view of Propeller showing beveled lugs.

Fig. 10.

Fig. 10. bottom view of Propeller.

Improved water-bottle, details.

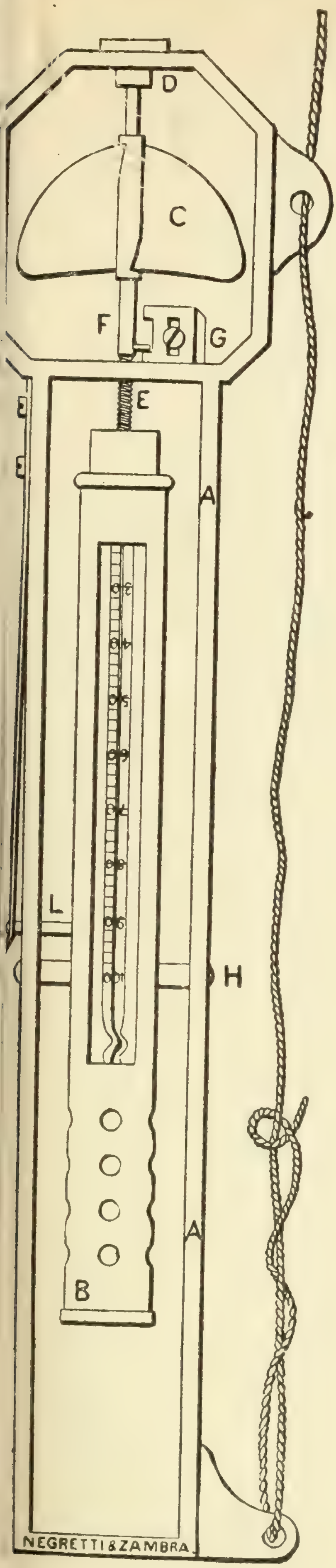


Fig.1.

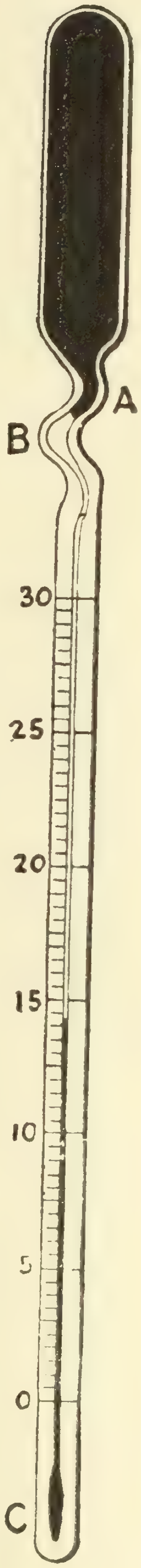


Fig.3.

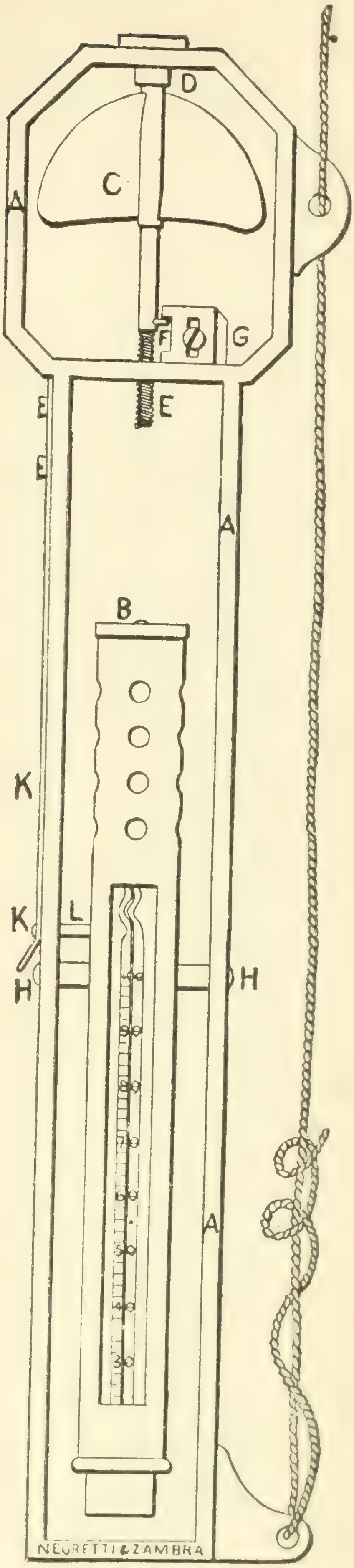


Fig.2.

Negretti & Zambra's patent improved frame, standard deep-sea thermometer.

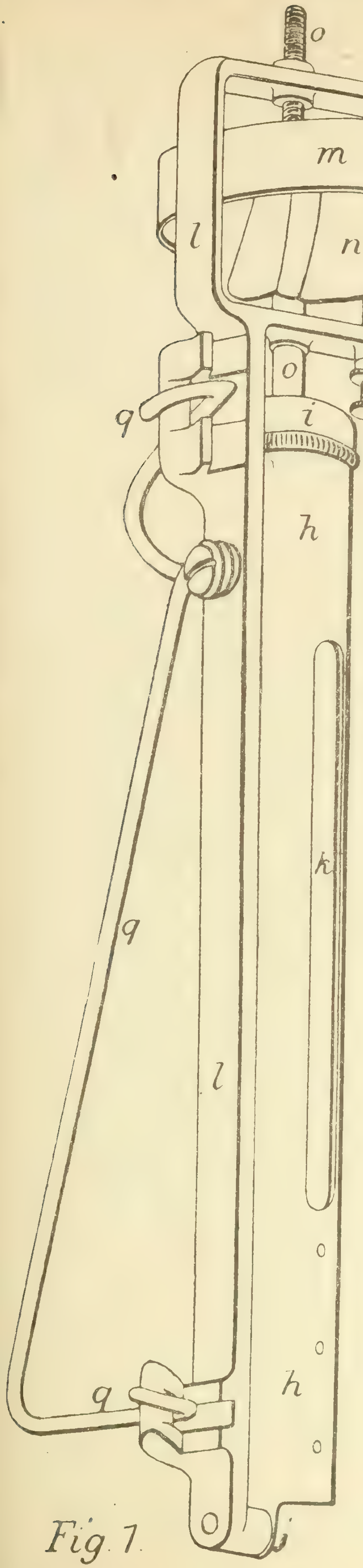


Fig. 1.

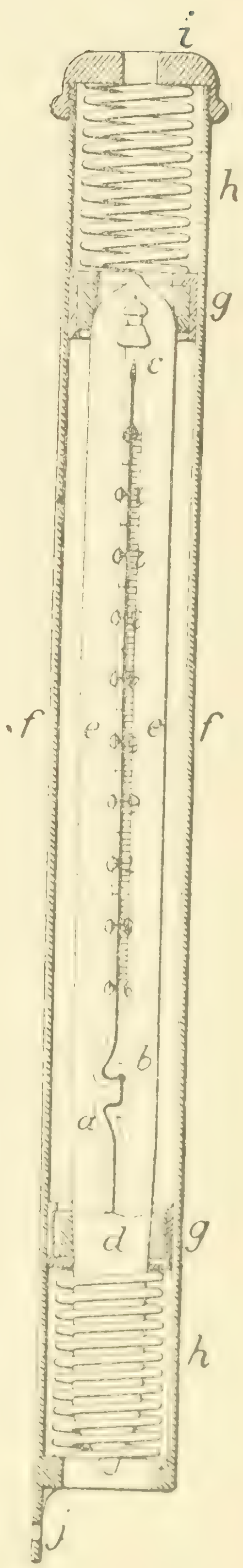
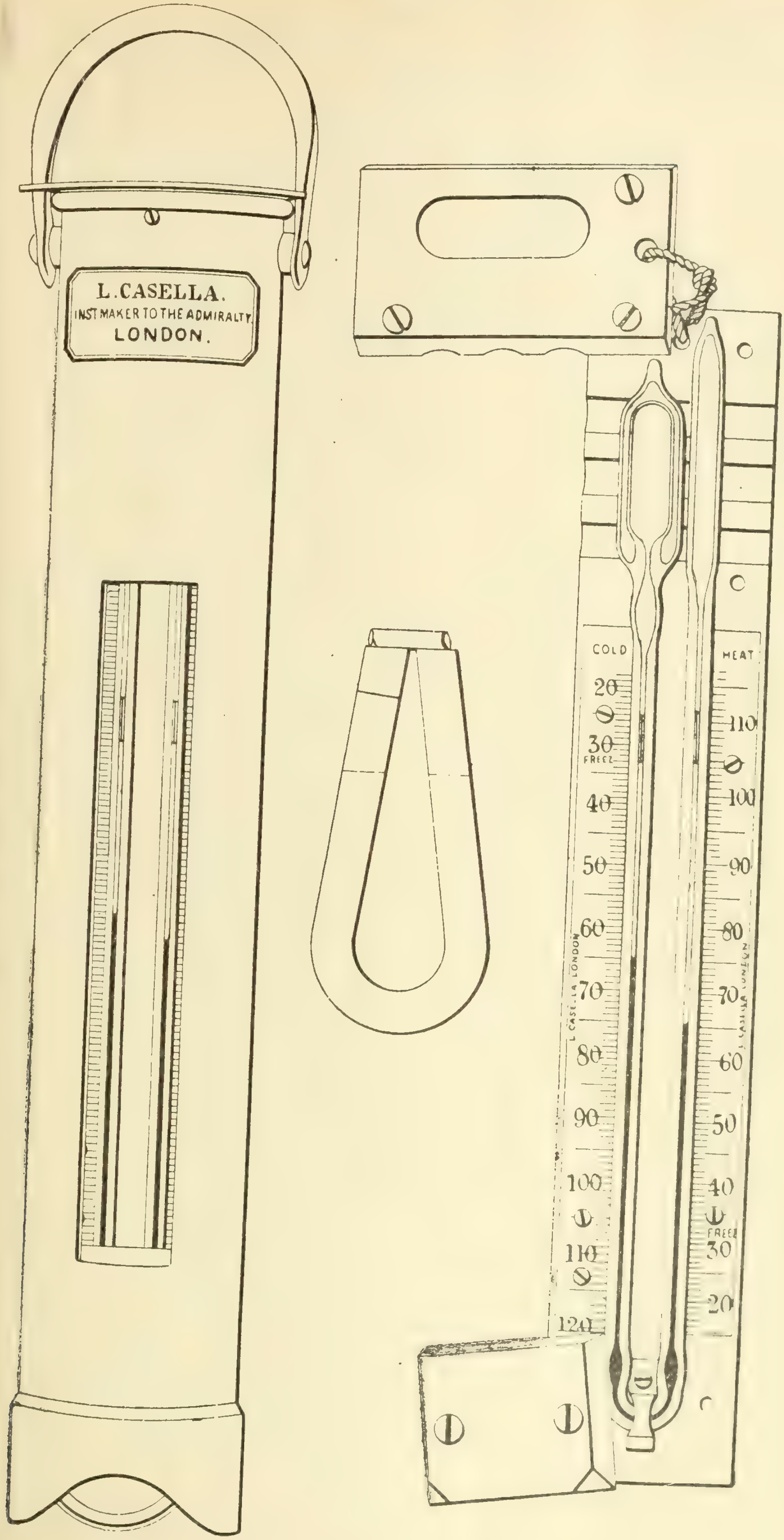


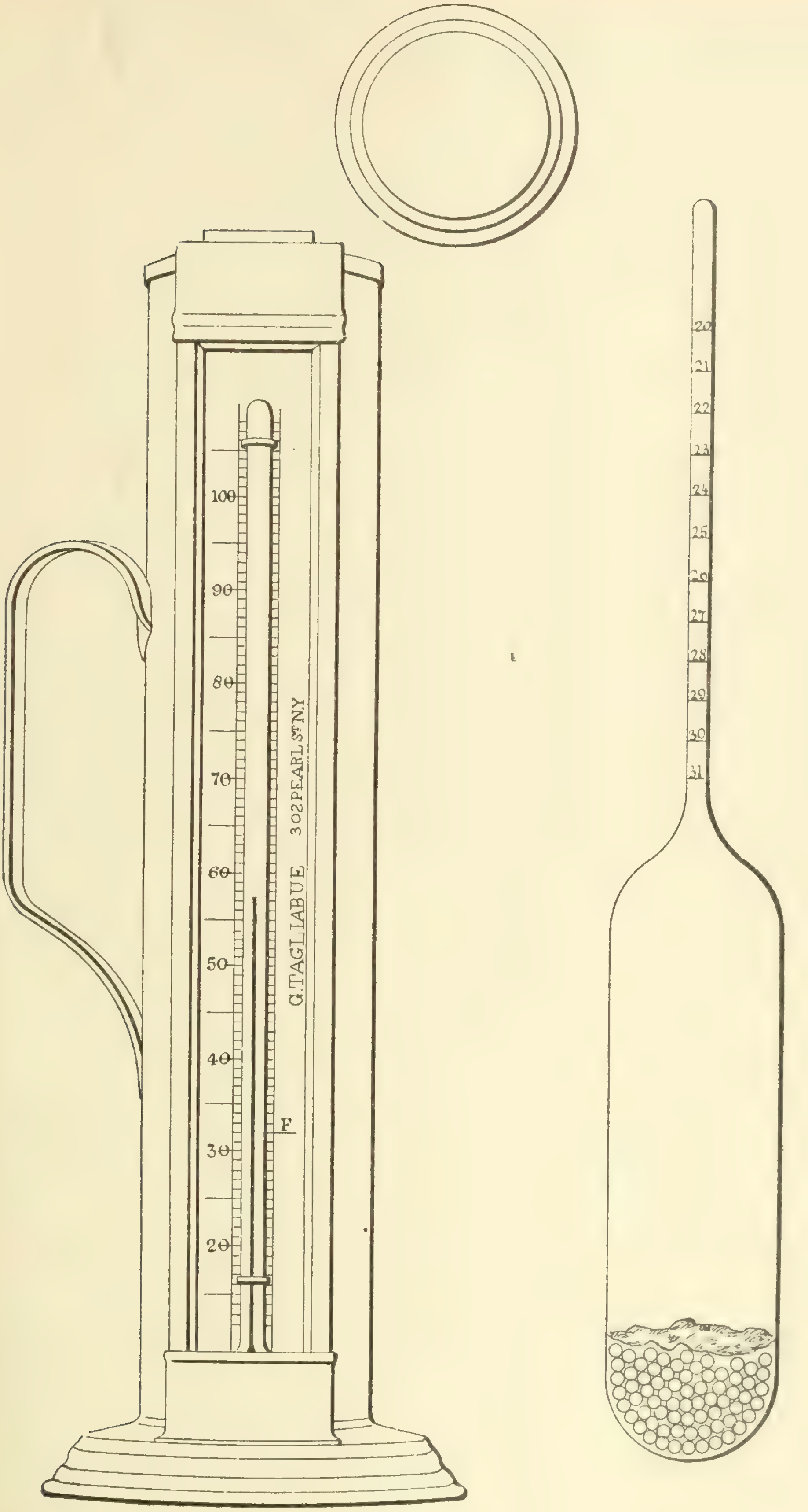
Fig 2.

ıe Tanner improved thermometer case, with the Sigsbee clamp, used with the Negretti & Zambra deep-sea thermometer.

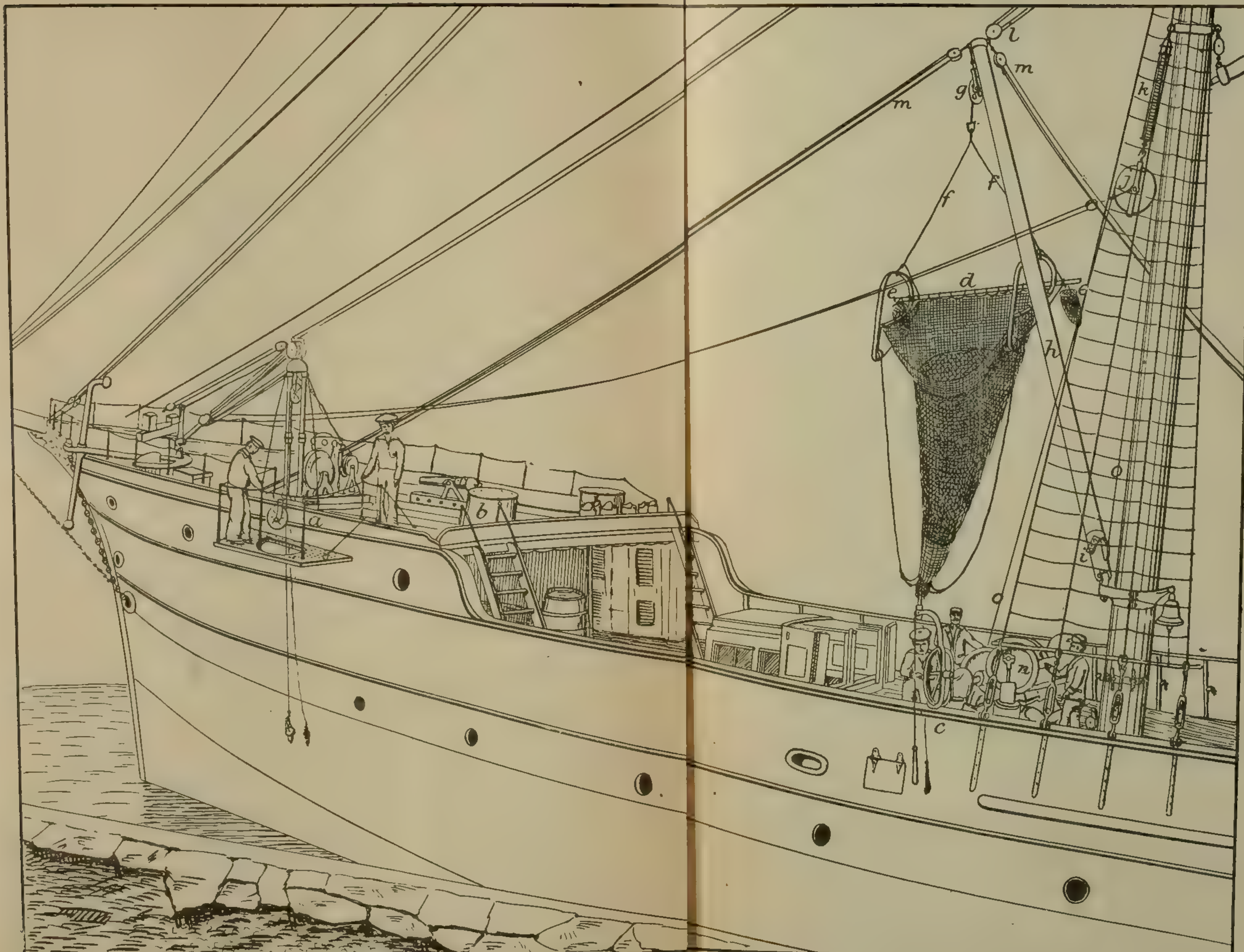
PLATE XL.



The Miller-Casella deep-sea thermometer.



Hilgard's ocean salinometer.



The bow of the Albatross, showing the location of the dredging boom and sounding machine.

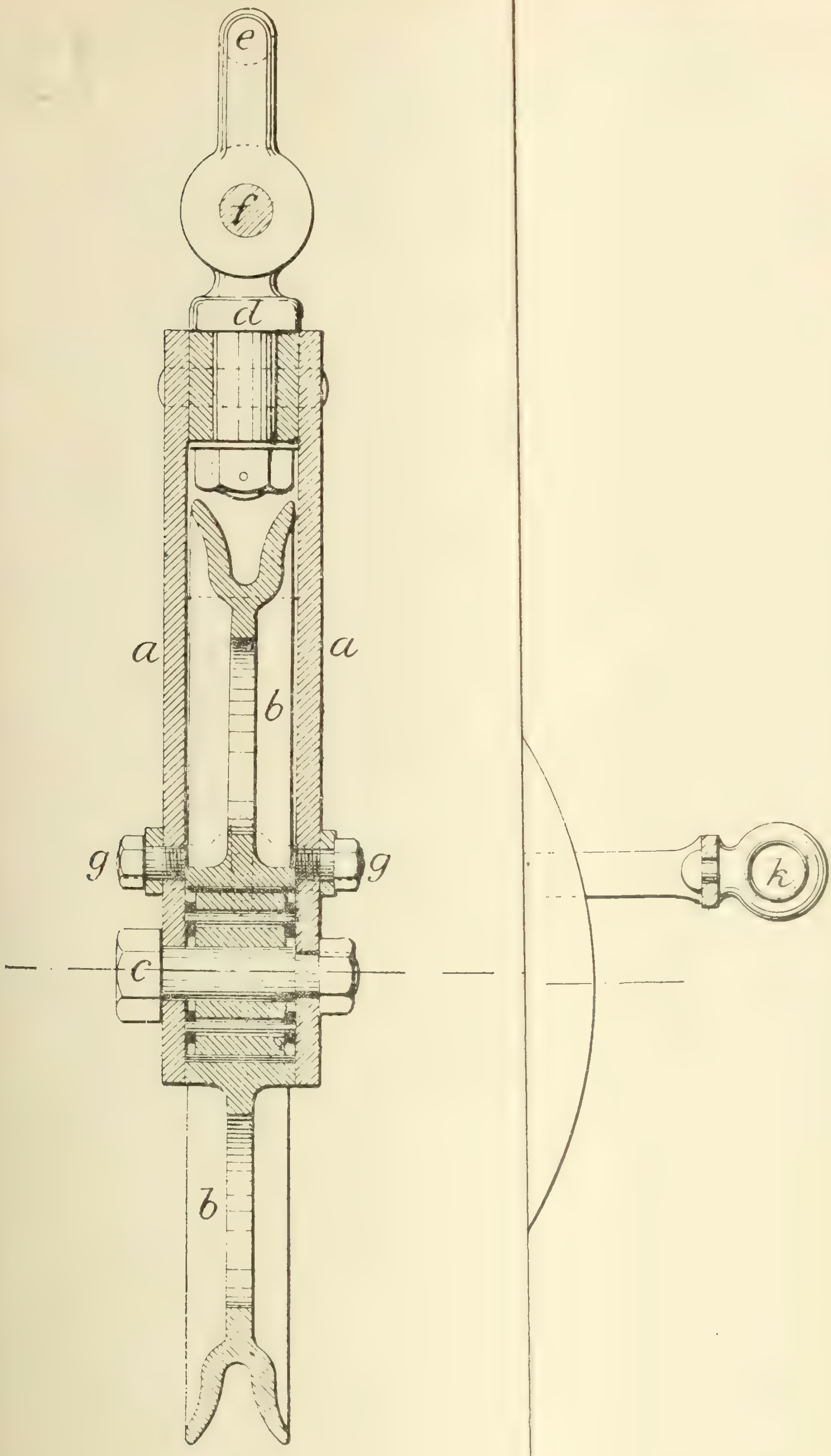
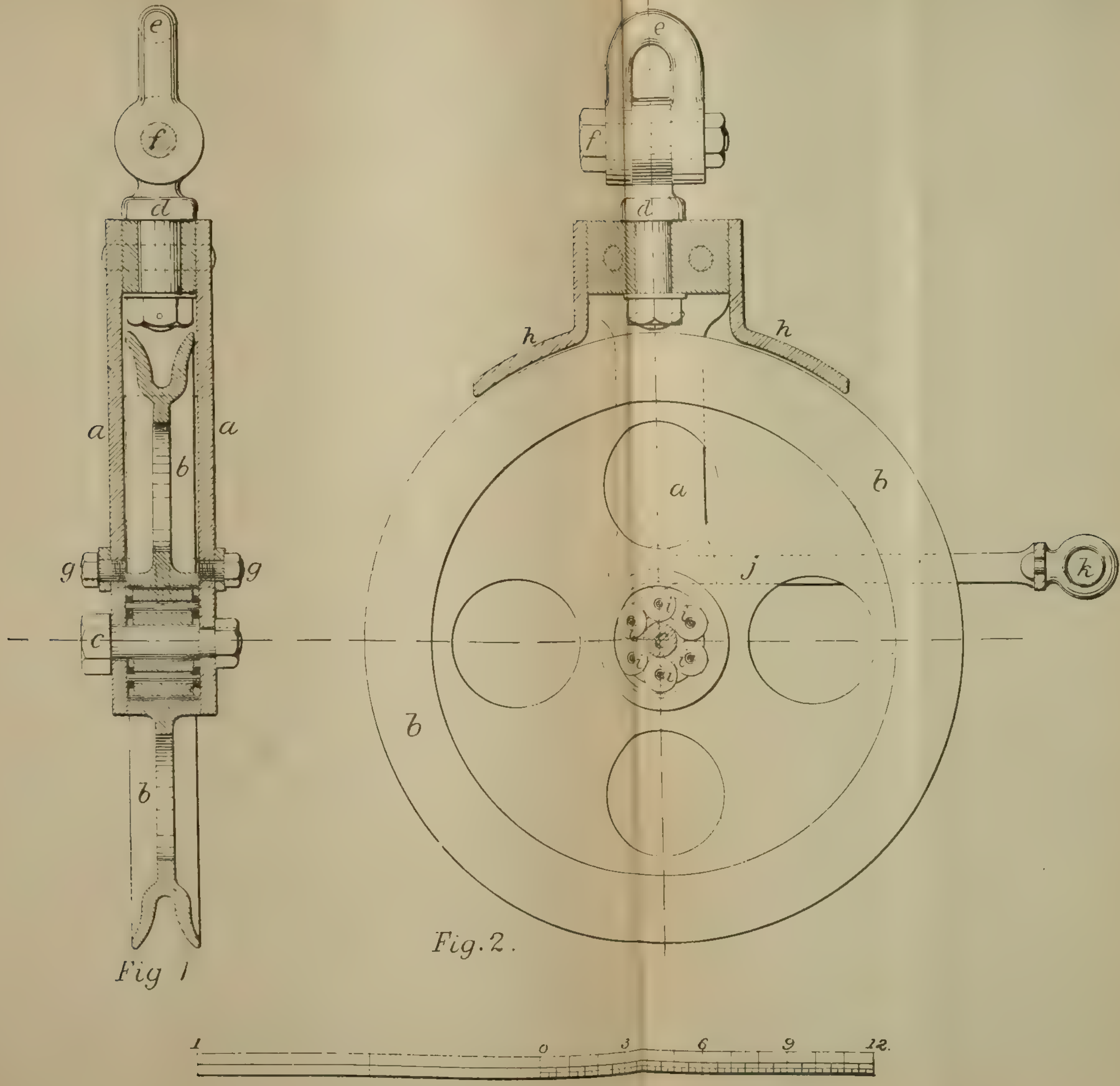
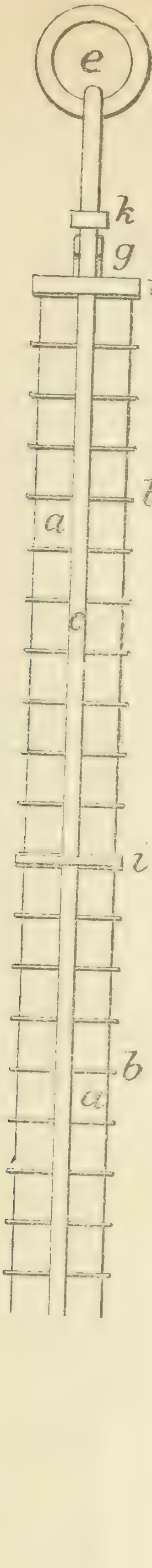


Fig. 1.



Dredging block.



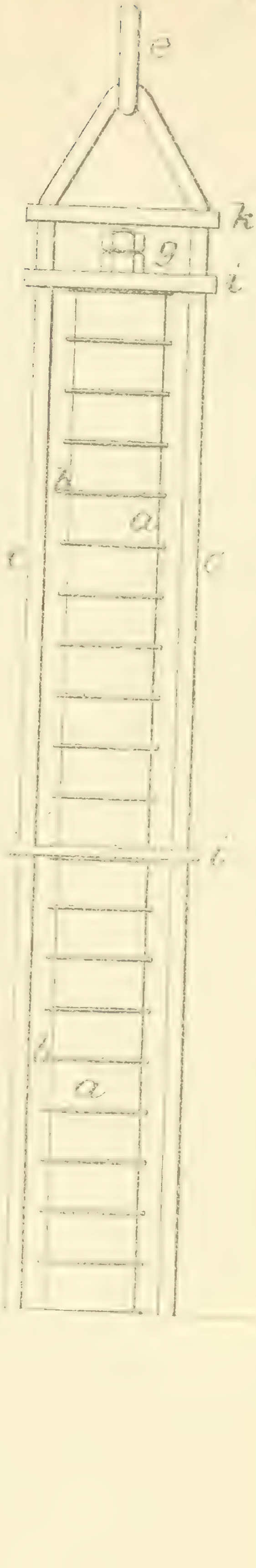


Fig. 3

Fig. 4.

Fig. 5.

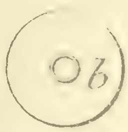
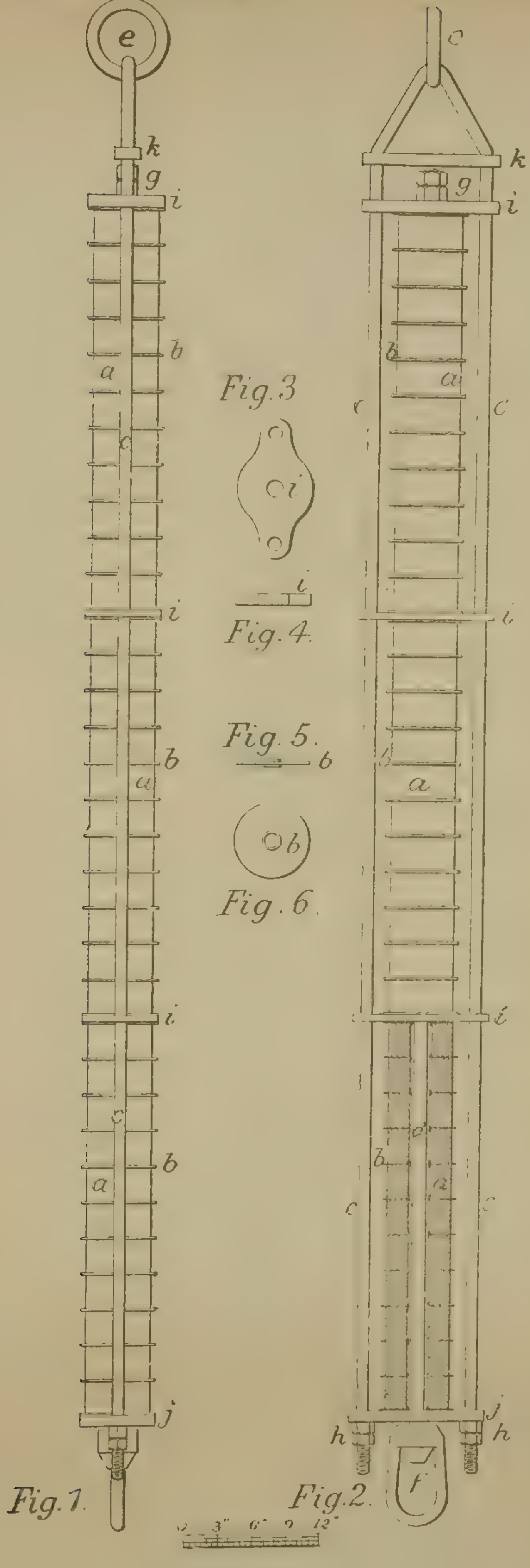
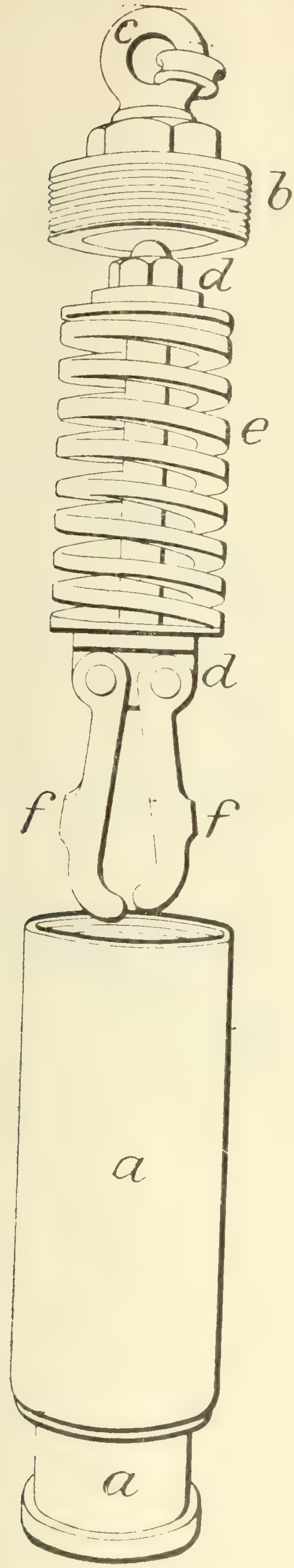


Fig. 6.

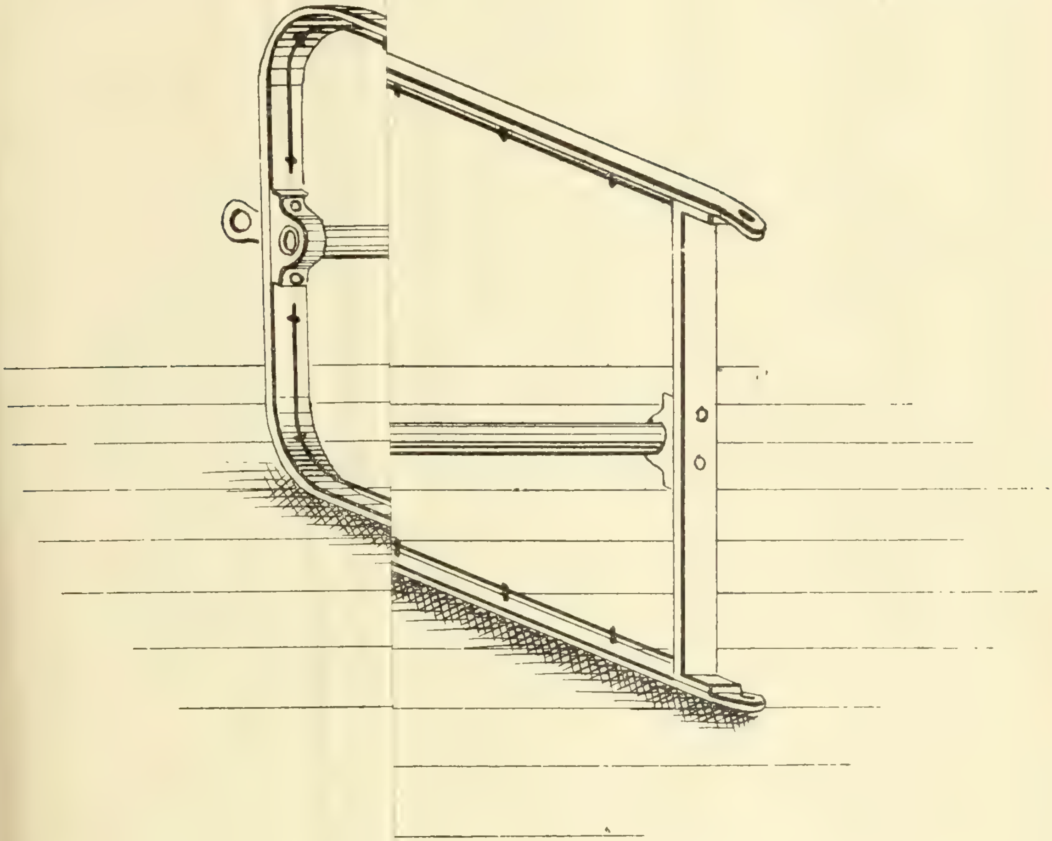


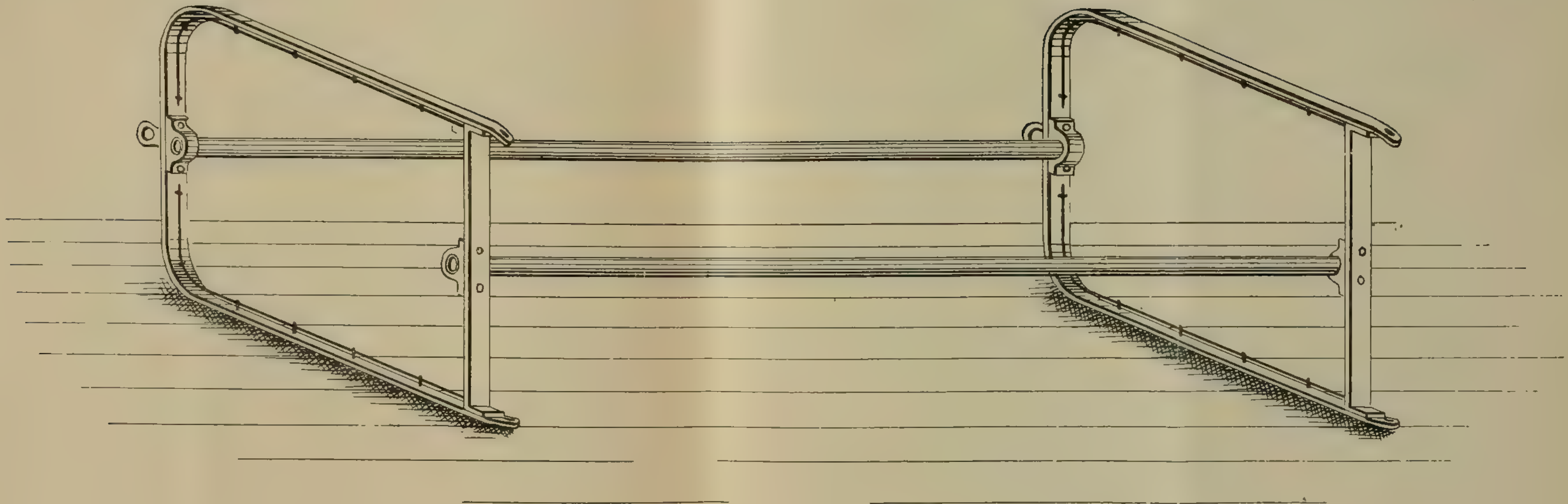
The accumulator.



Safety-hooks.

PLATE XLVI.

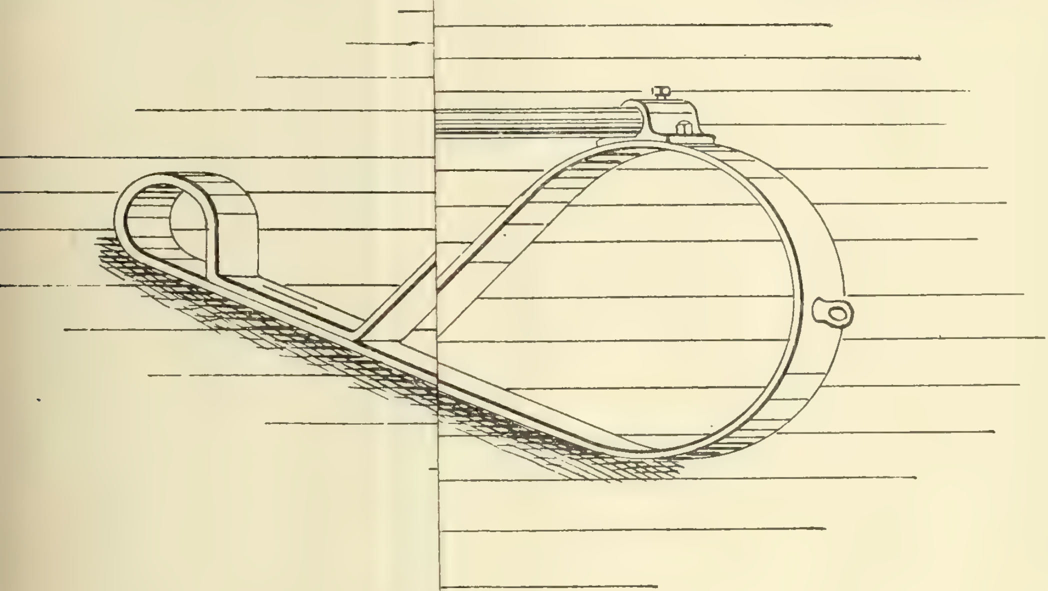


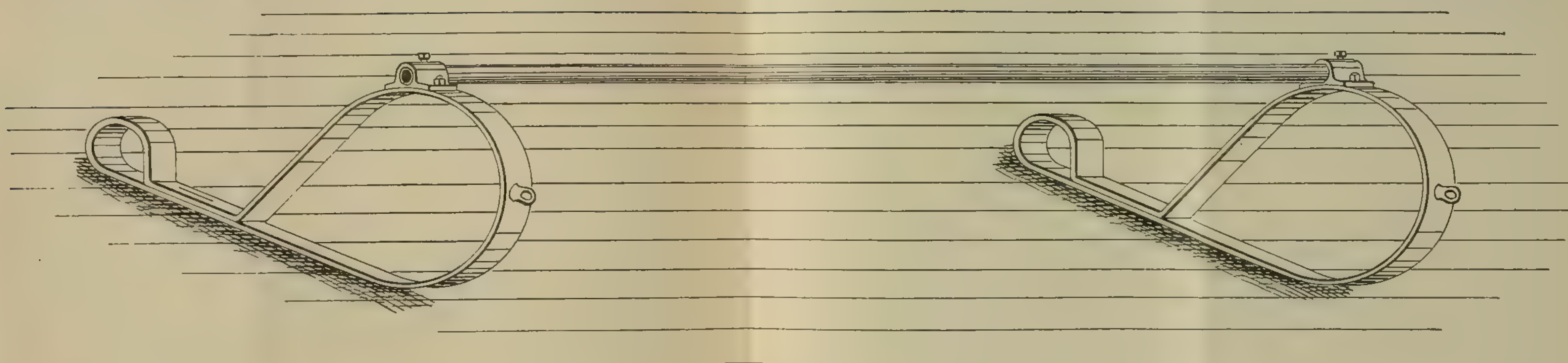


Deep-sea trawl-frame.

Scale: ½ inch = 1 foot.

PLATE XLVII.

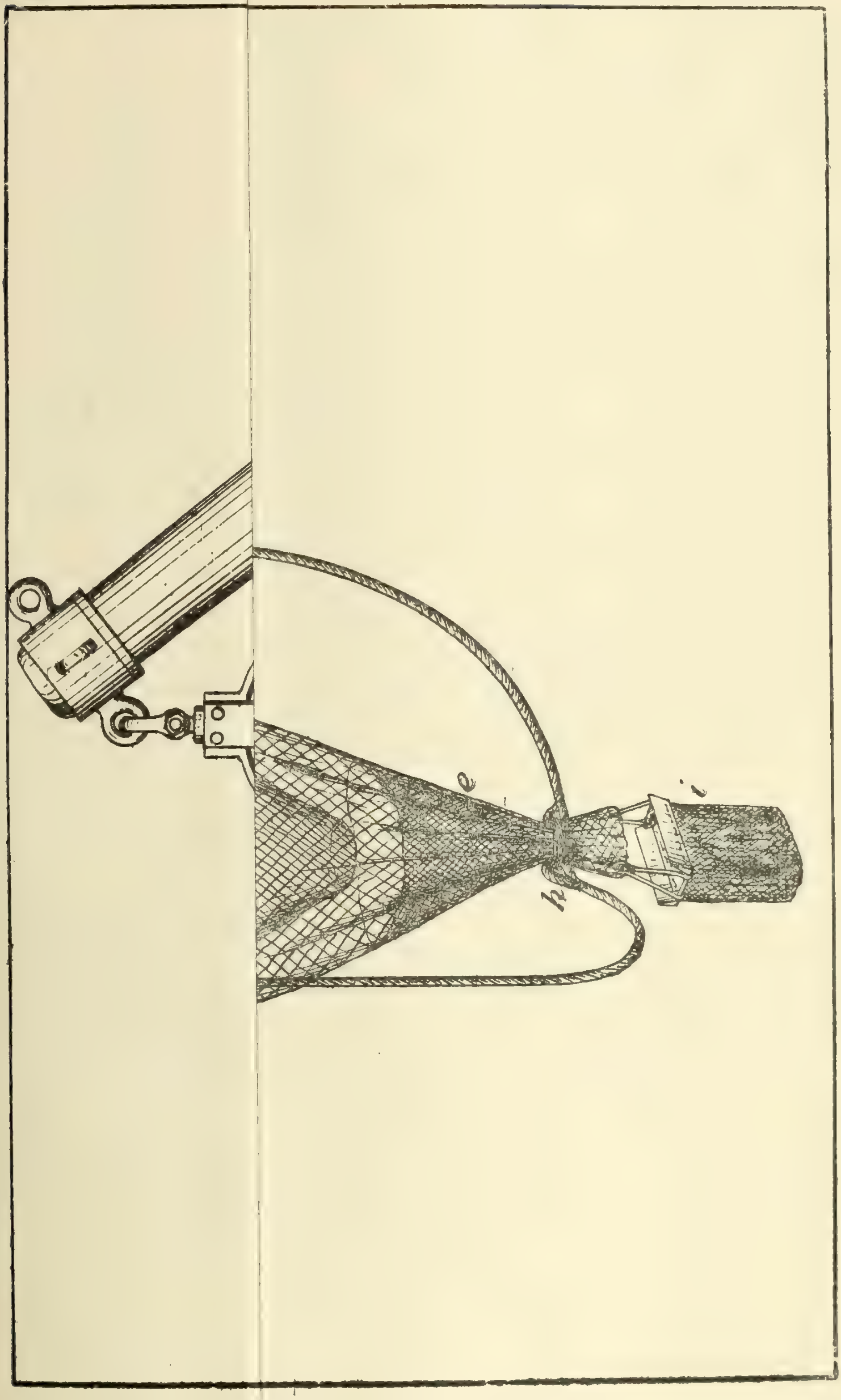


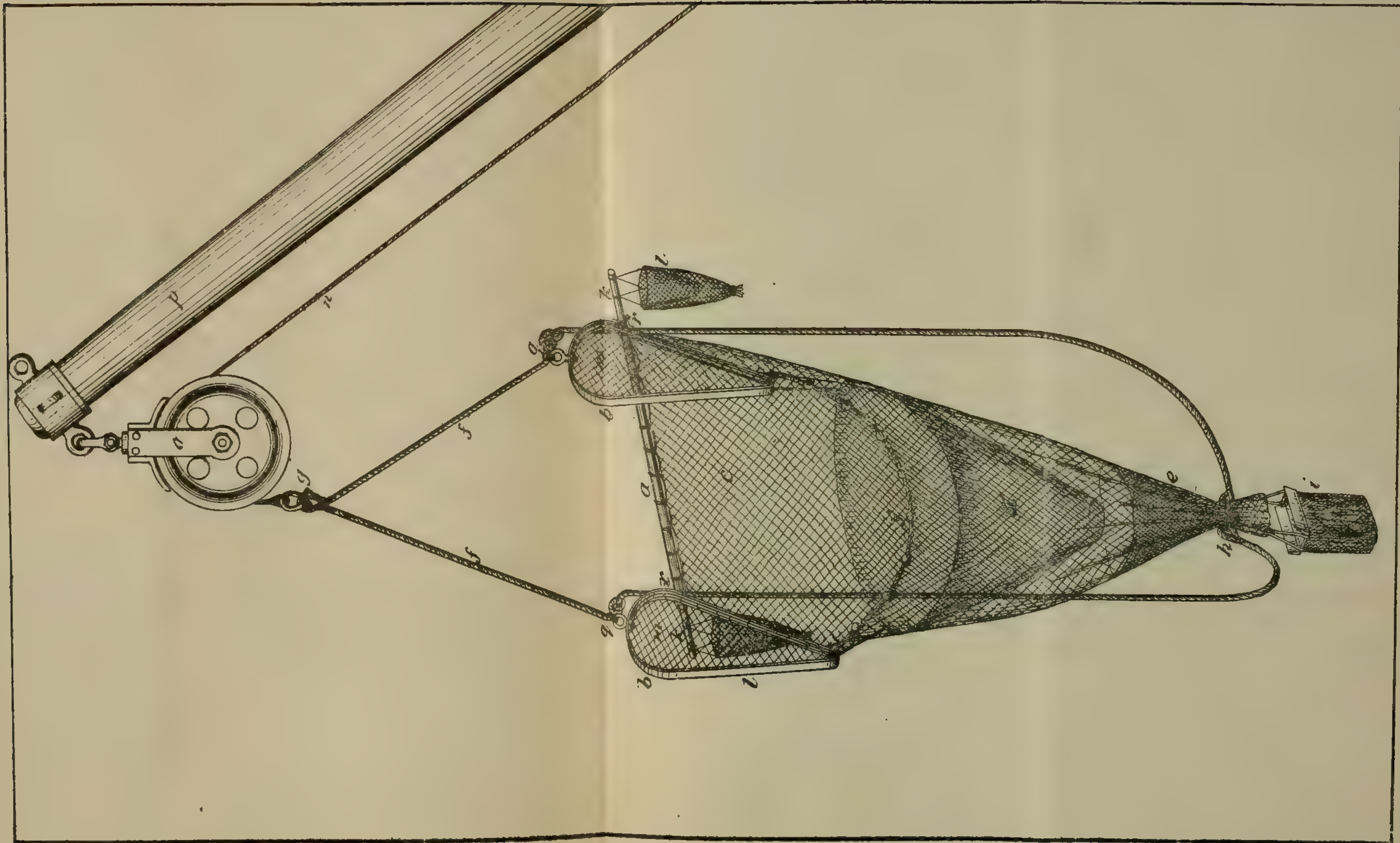


Beam-trawl frame.

Scale: ½ inch = 1 foot.

PLATE XLVIII.





Improved beam-trawl.

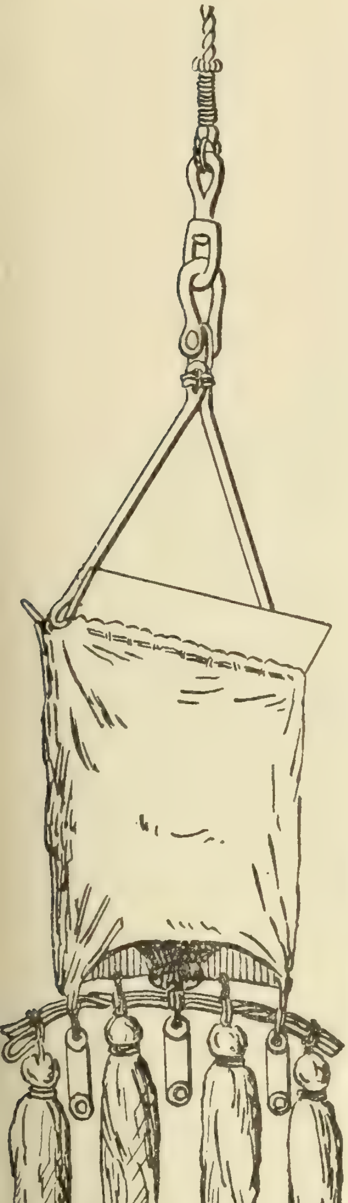
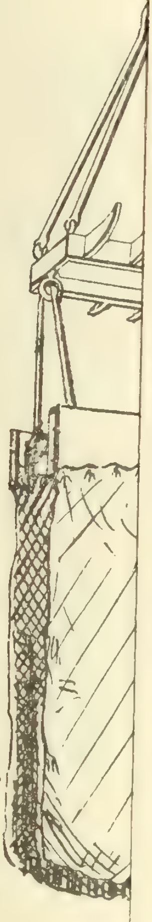


Fig. 1.



F

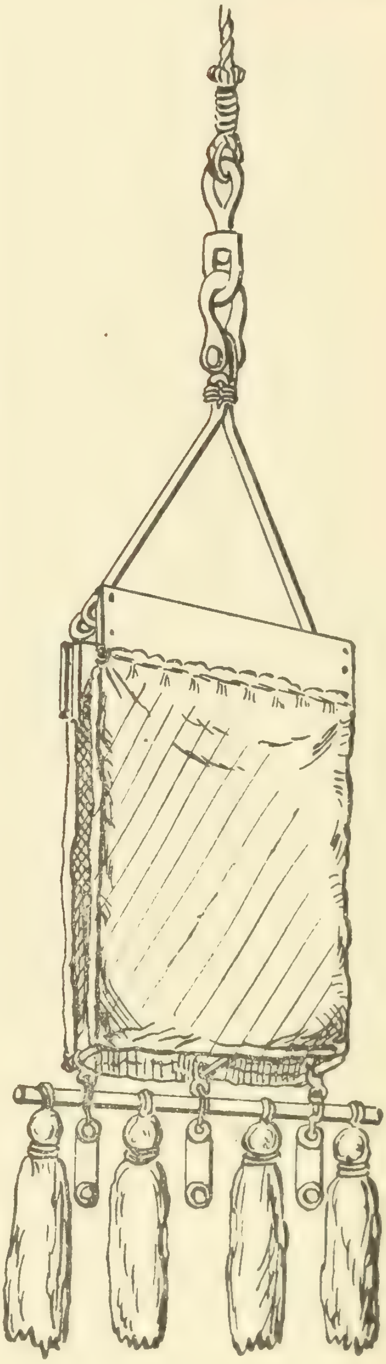


Fig. 4.

1

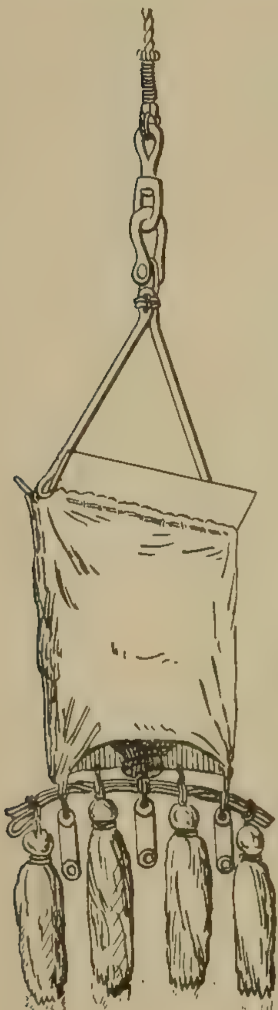


Fig. 1.

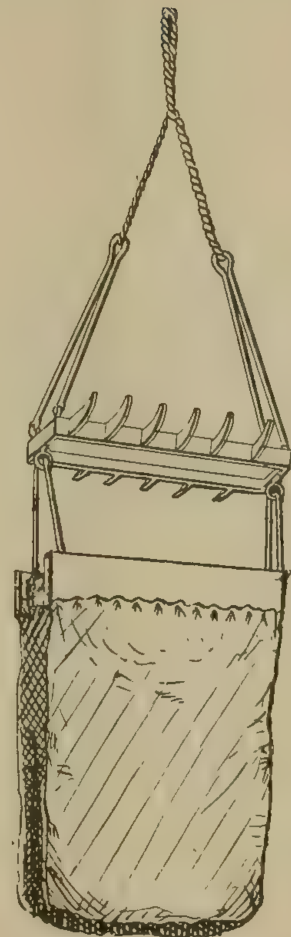


Fig. 2.

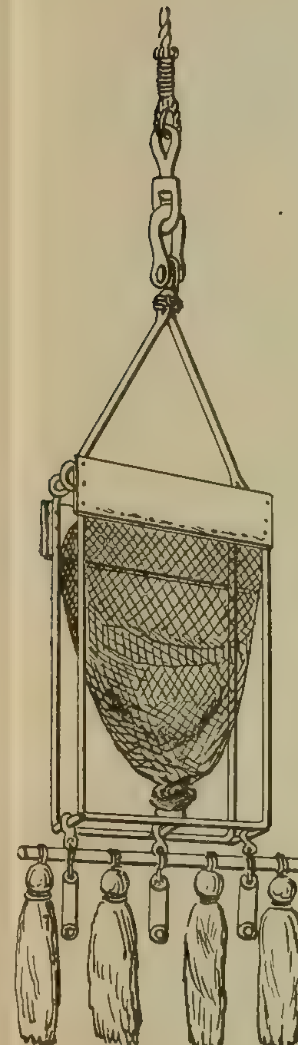


Fig. 3.

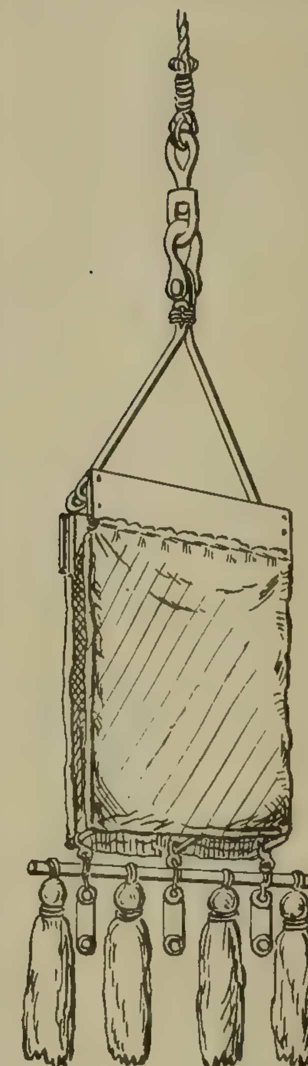
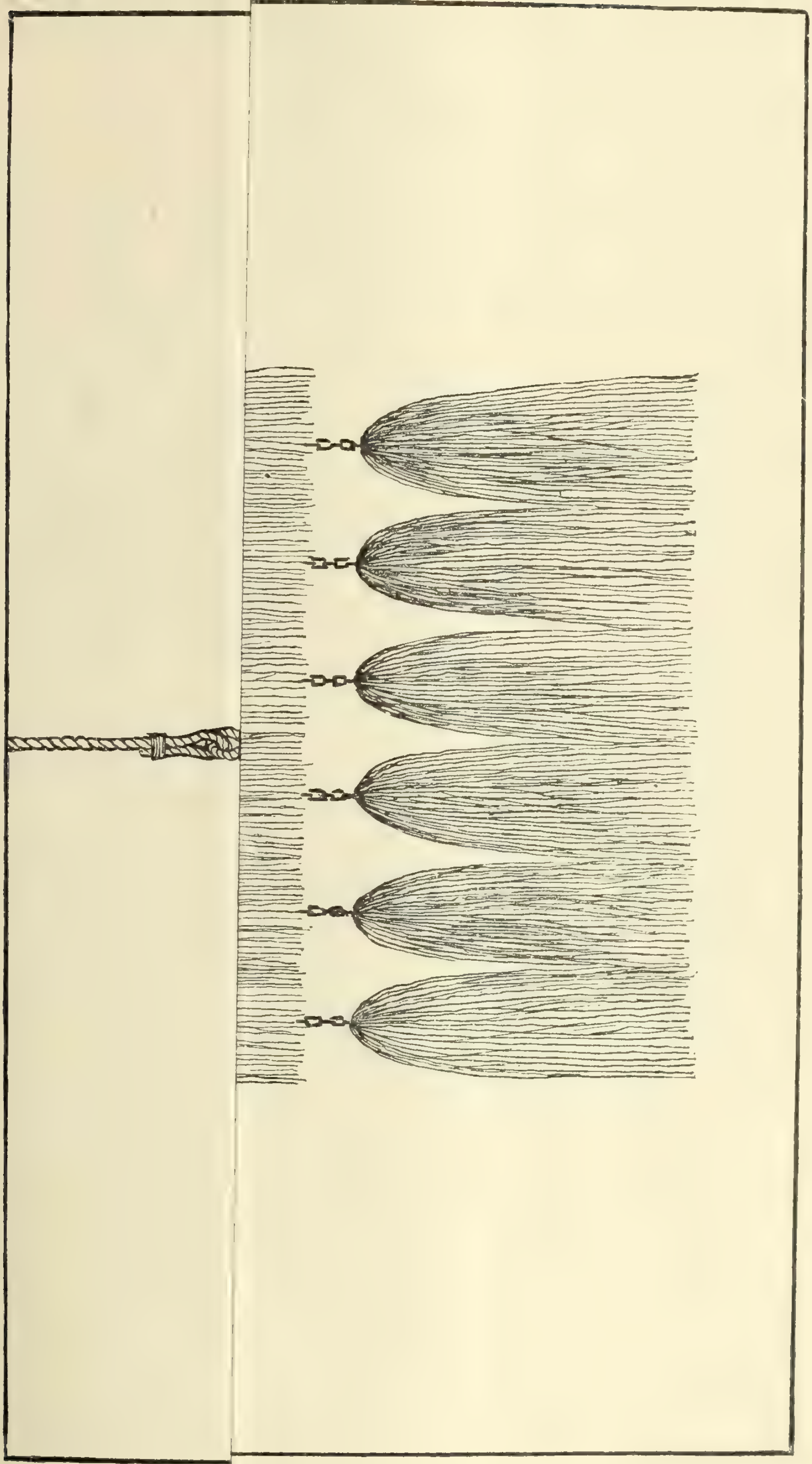
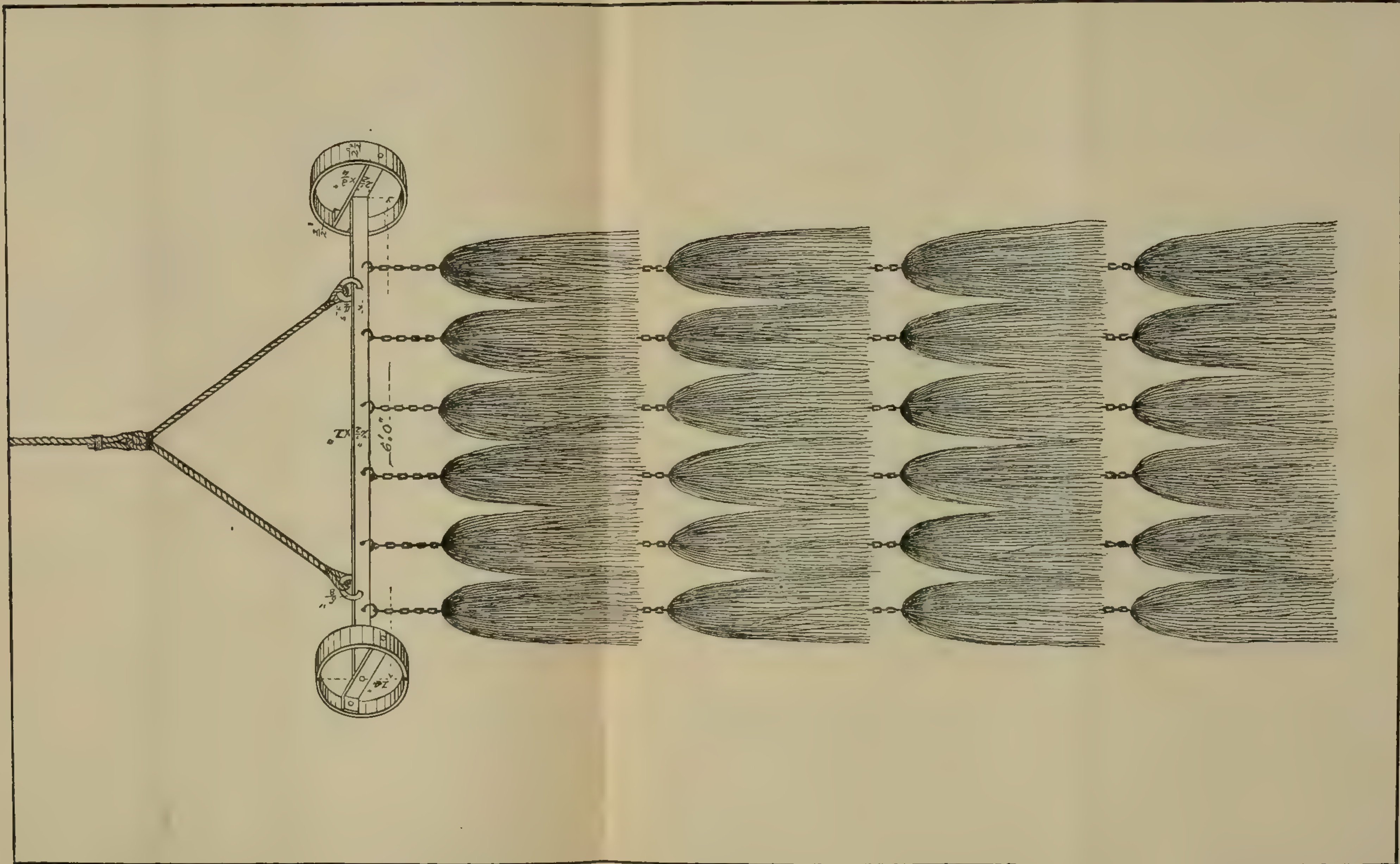


Fig. 4.

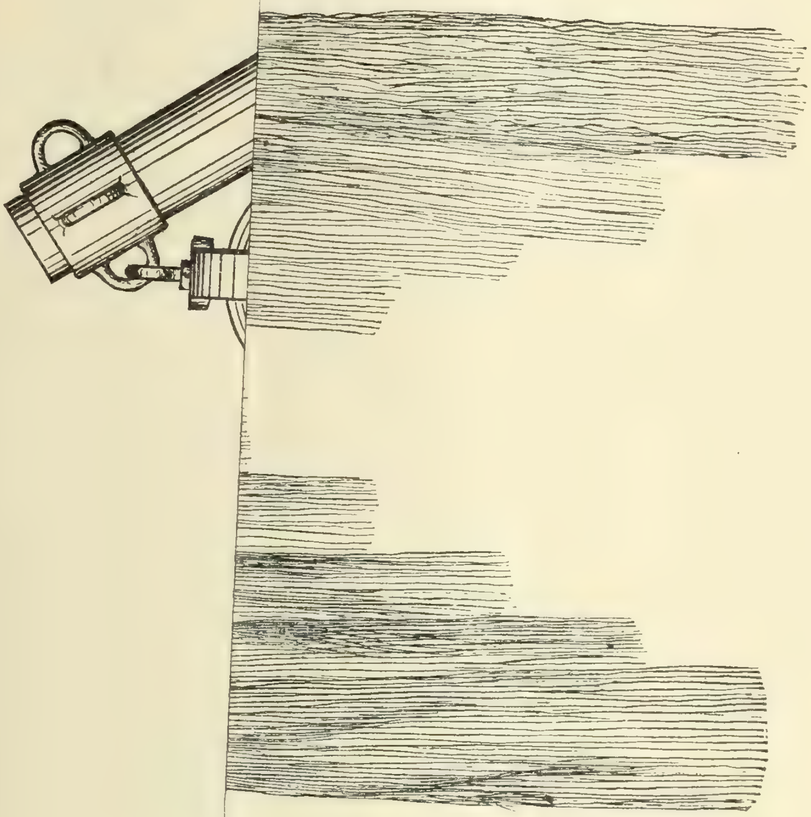
1. Common dredge. 2. Chester rake-dredge. 3 and 4. Blake dredge.

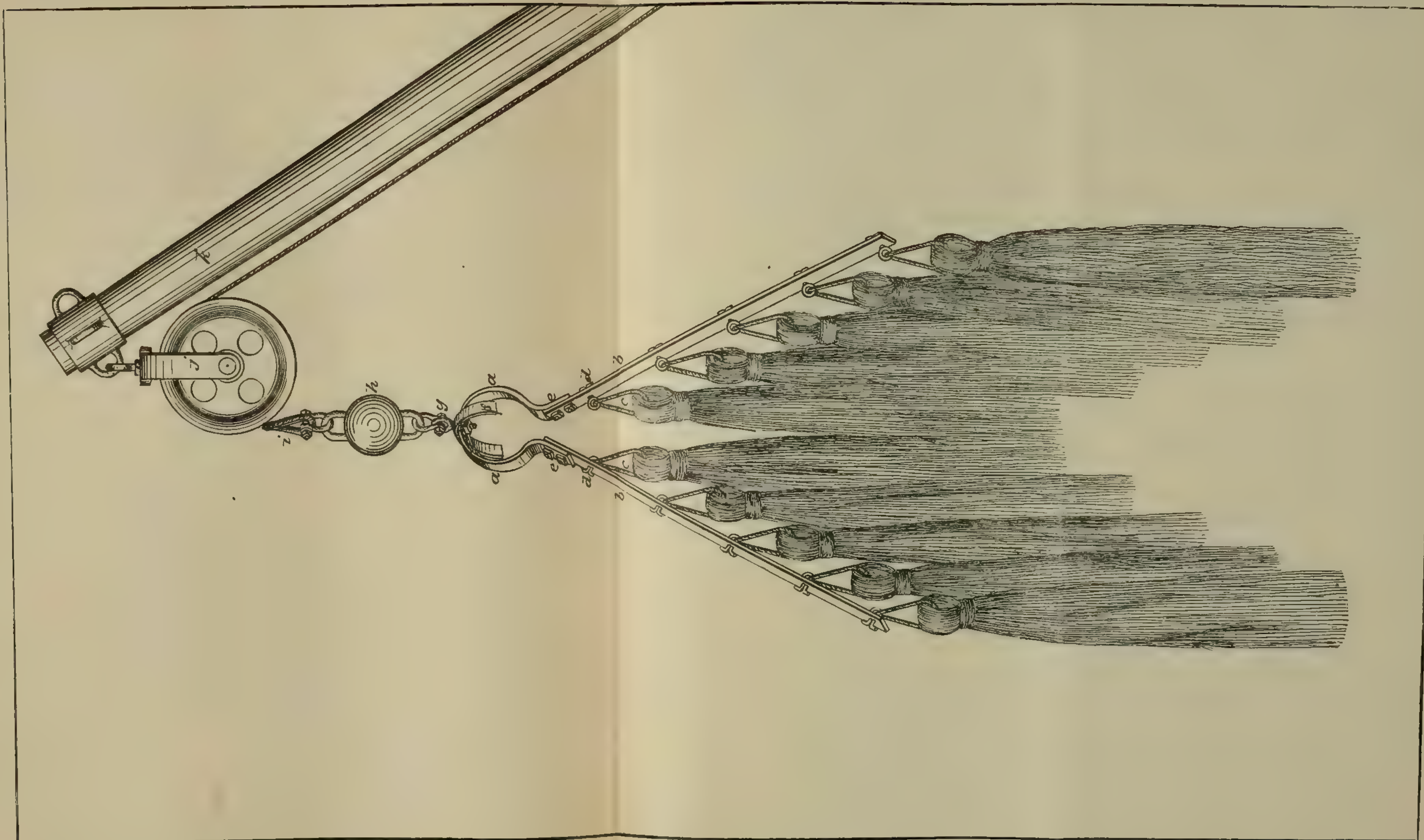




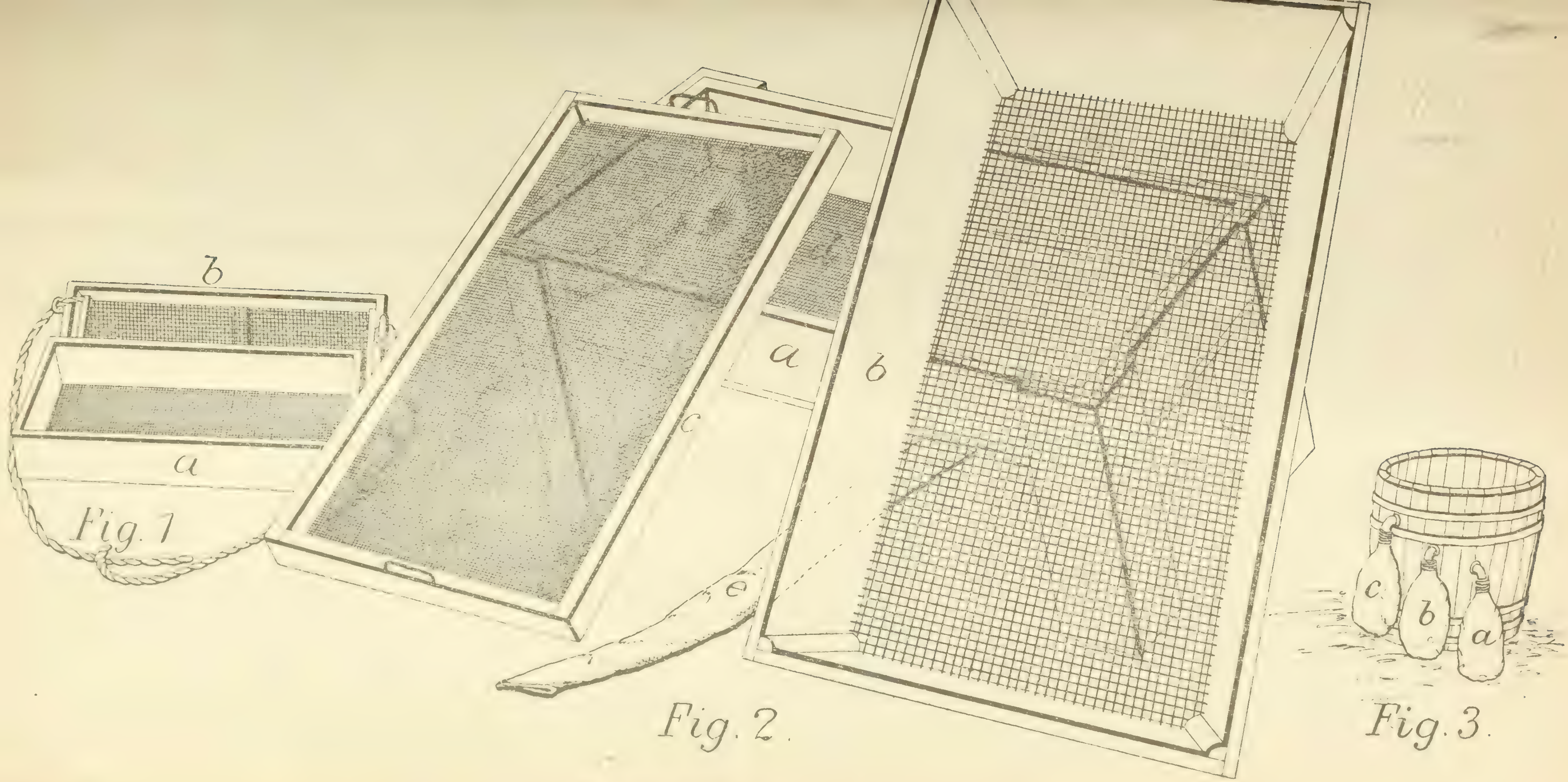
Tangle bar.

PLATE LI.

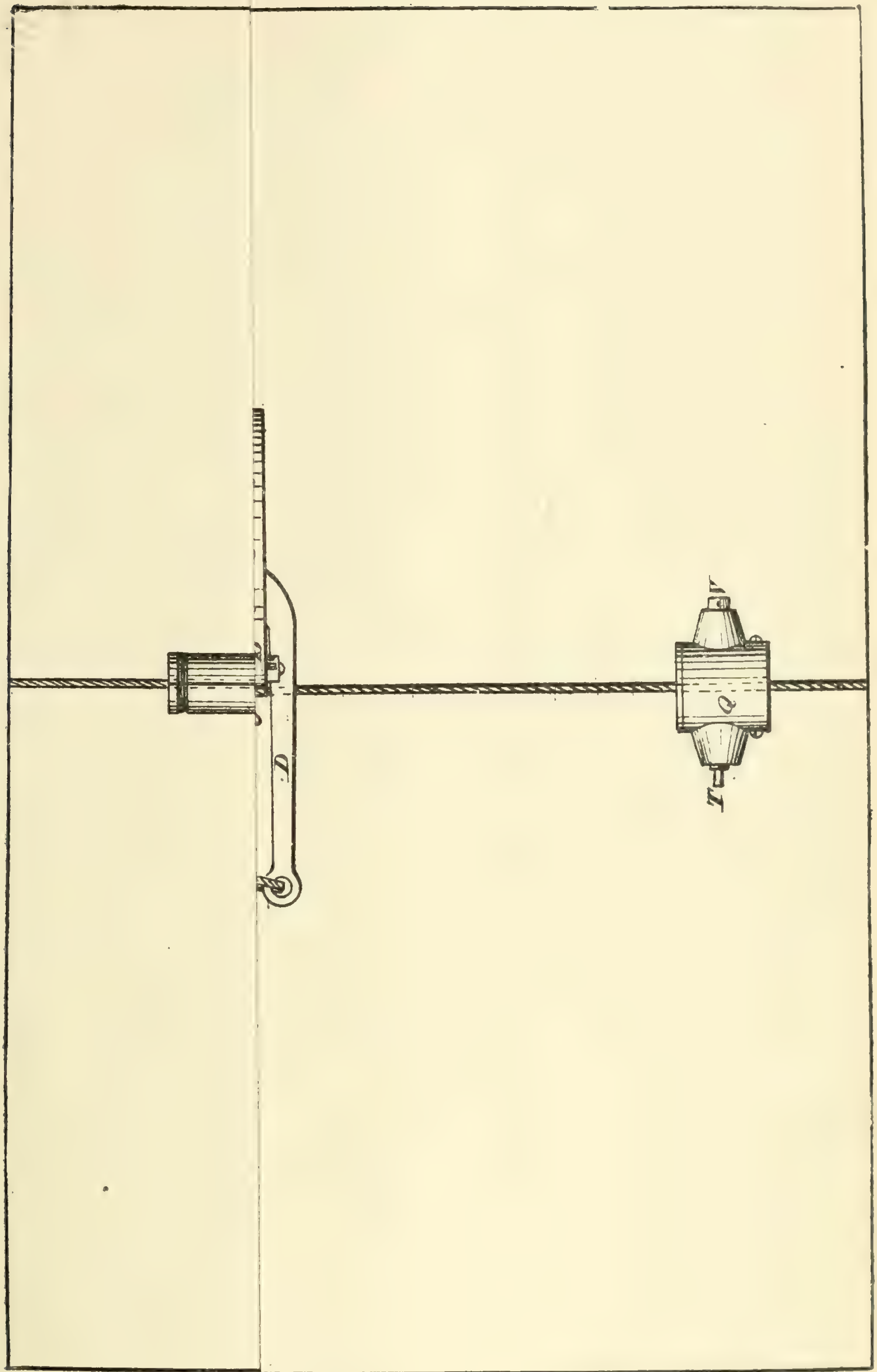




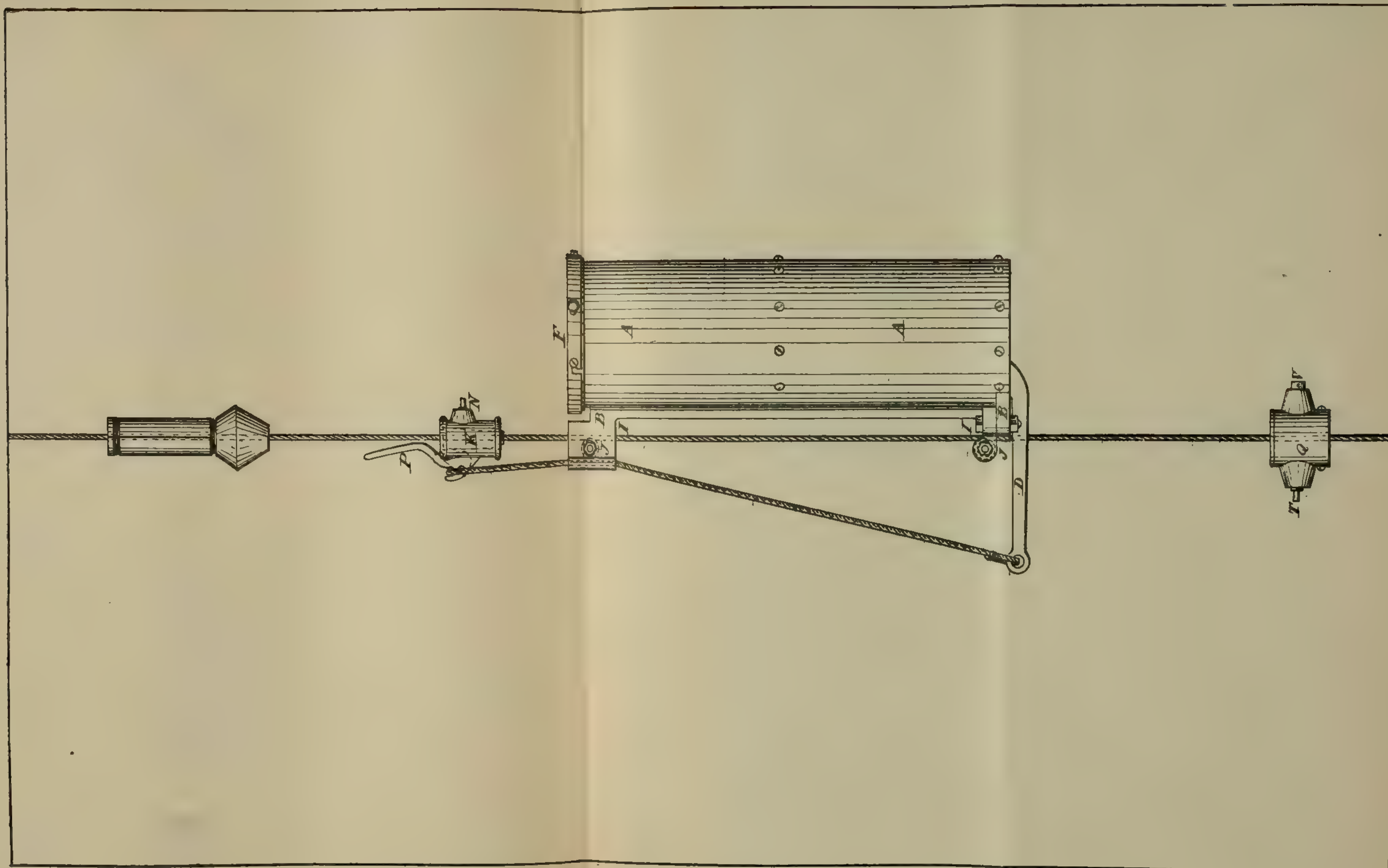
The tangles.



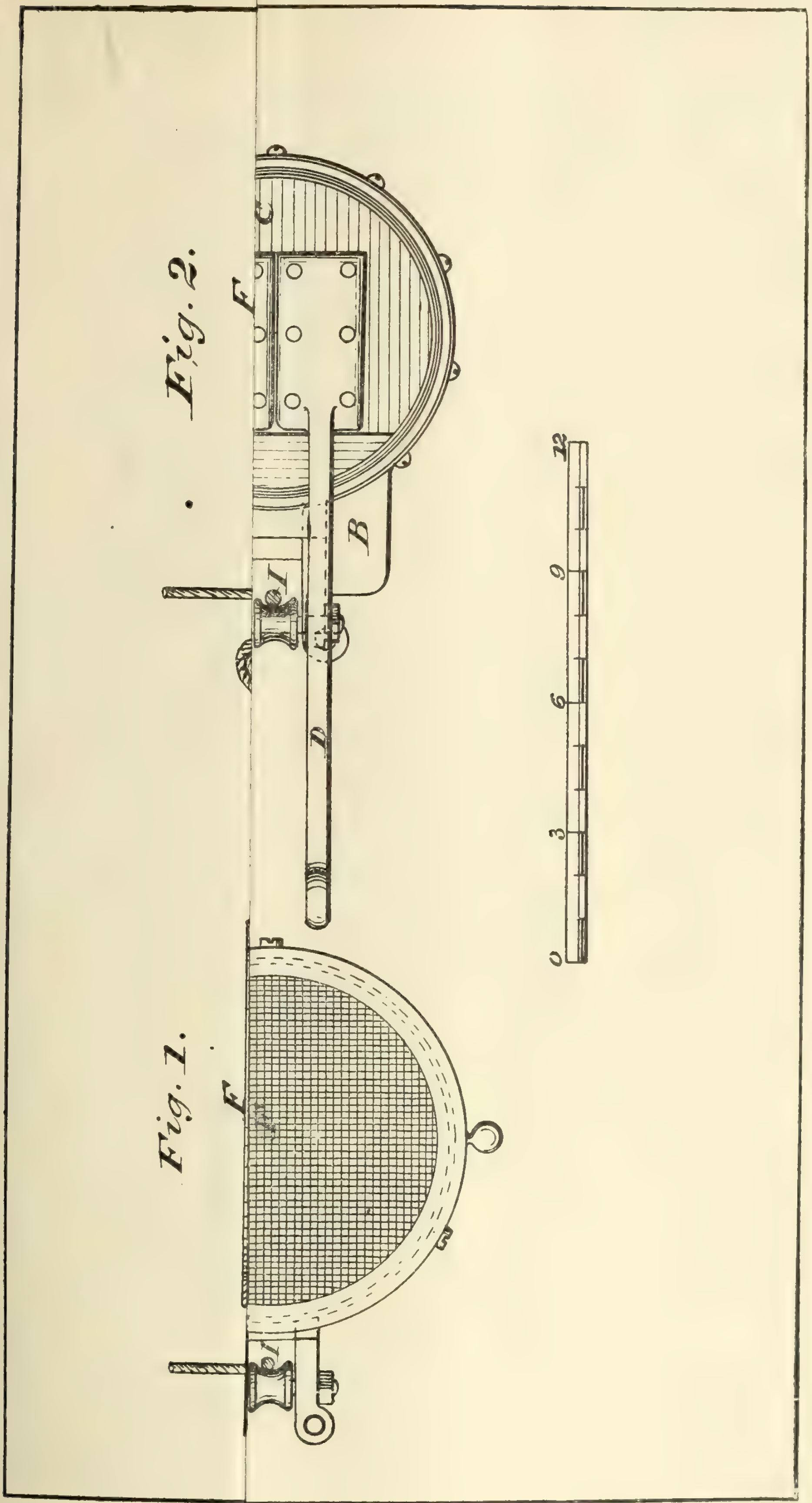
The cradle-sieve, table-sieve, and strainer.



s.

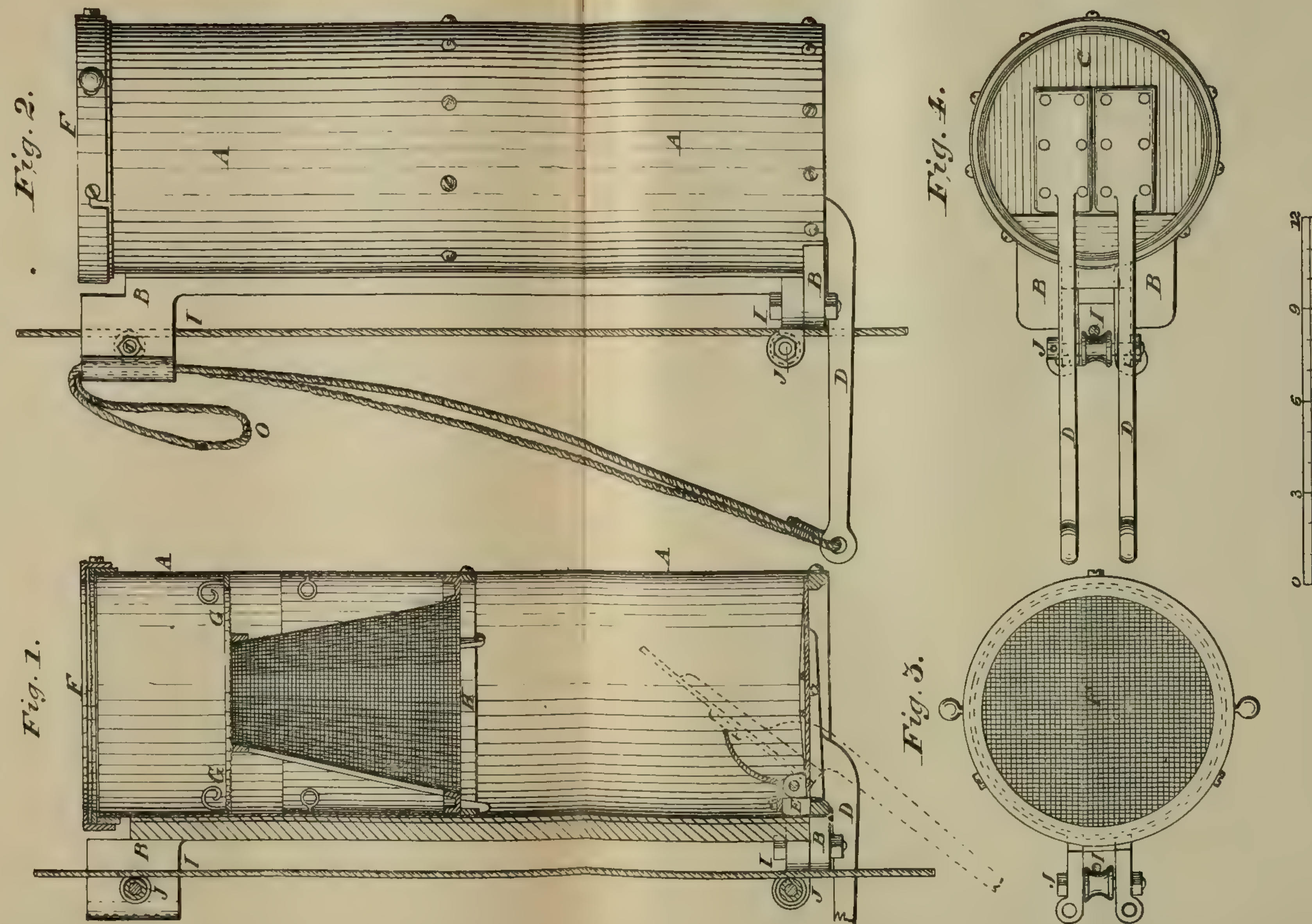


Sigsbee's gravitating trap for obtaining animal forms from intermedial ocean depths.



Bottom view.

PLATE LIV.



Sigsbee's gravitating trap.—Fig. 1. Sectional elevation. Fig. 2. Side view. Fig. 3. Top view. Fig. 4. Bottom view.

PLATE LV.

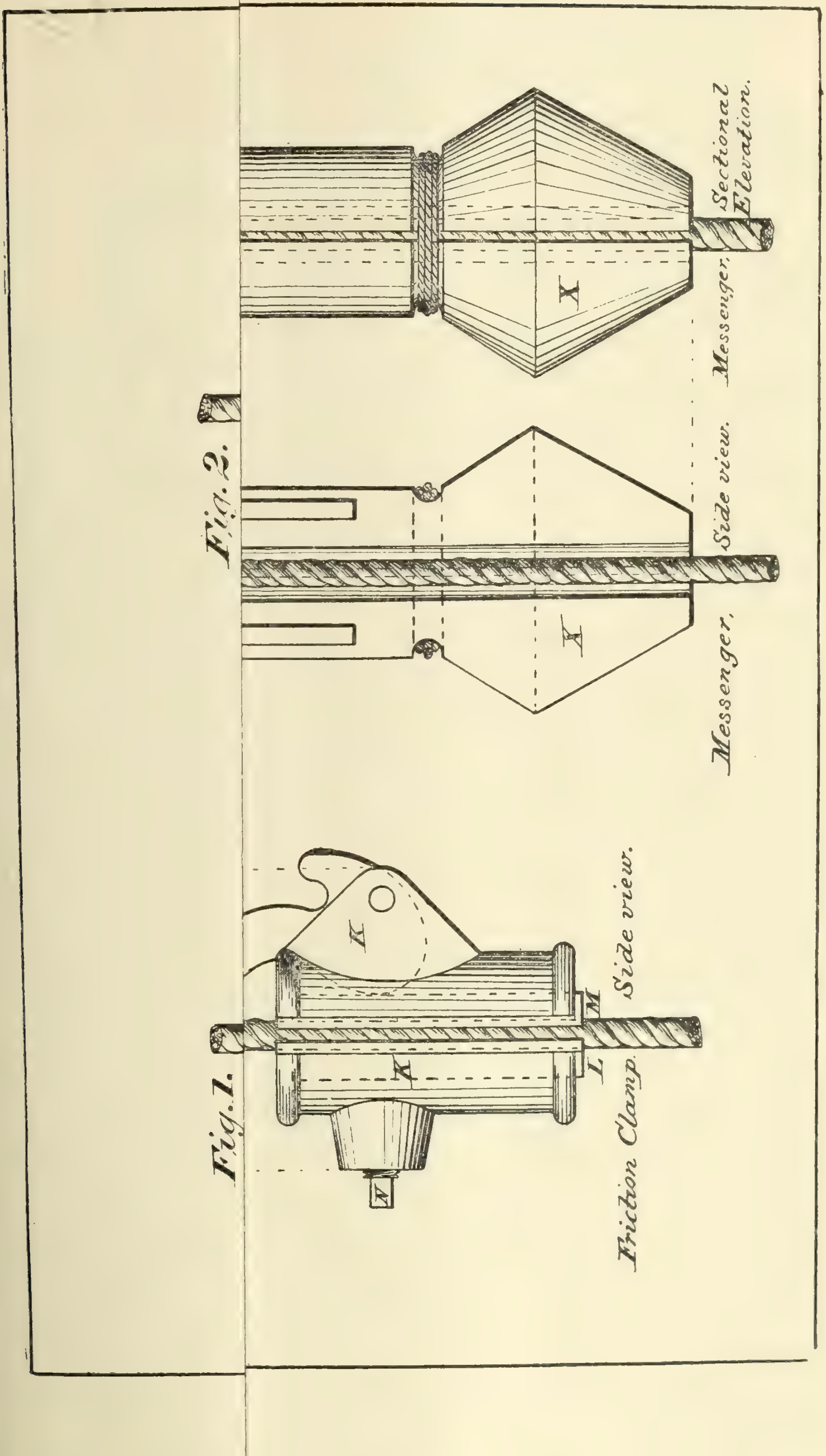
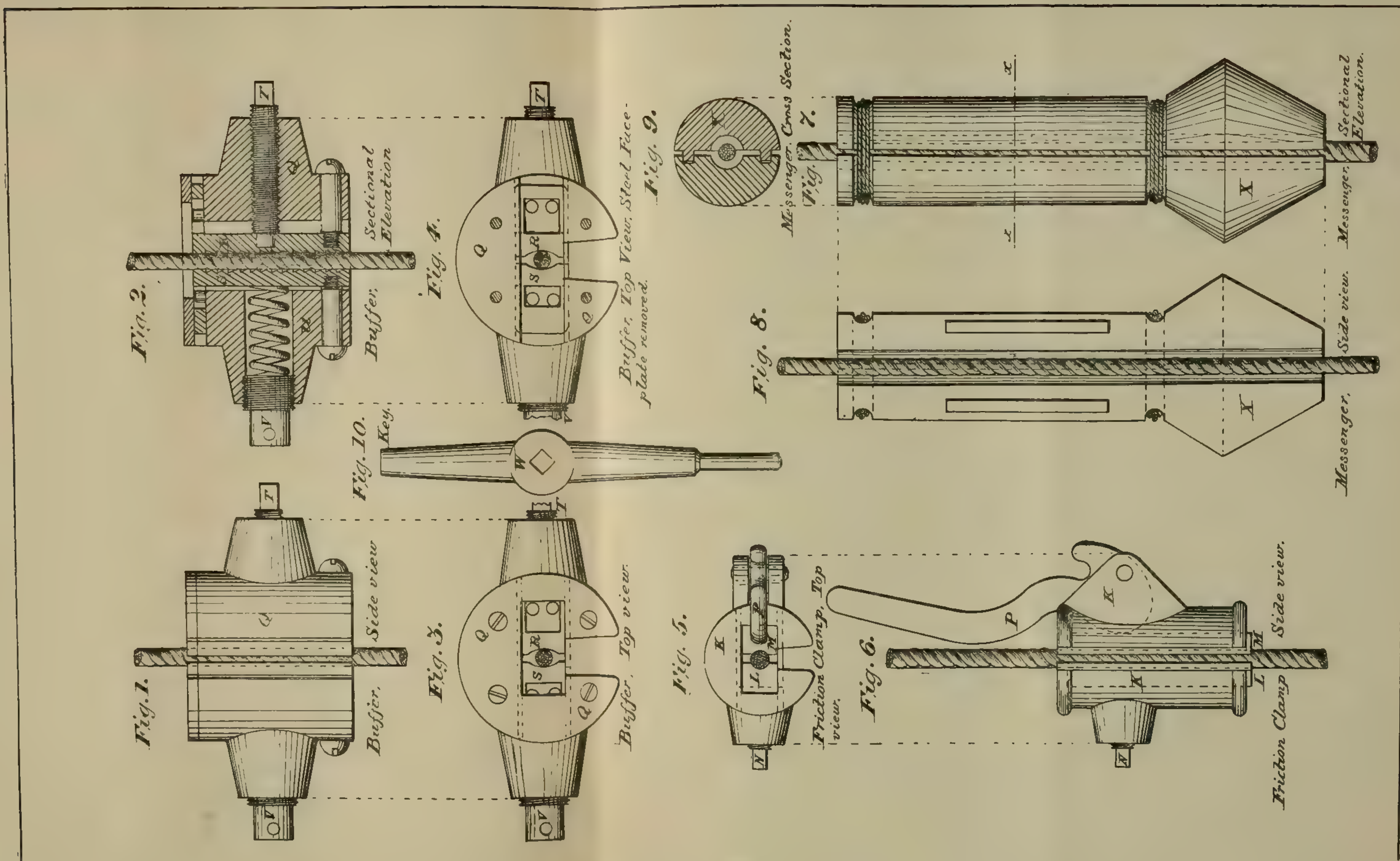


Fig. 1.
Friction Clamp. Side view.
K
L
M
N
Fig. 2.
Messenger, Side view.
Messenger, Sectional Elevation.
X



Sigsbee's gravitating trap.

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II.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS FOR THE YEAR ENDING DECEMBER 31, 1883.

By Lieut.-Commander Z. L. TANNER, U. S. N., *Commanding.*

At the close of my last report the vessel was at anchor off Blackistone Island, Potomac River, bound from Wilmington, Del., to Washington, D. C., on her trial trip.

At 6.20 on the morning of January 1 we got under way and steamed up the river. A serious difficulty had been experienced in working the engine promptly, the trouble arising partly from the crank angle (145°) and partly from insufficient power of the reversing engines. At 11.30 a. m., when off Quantico, Va., we commenced working the engines by signal in order to test the efficiency of the reversing gear and the practicability of working the engines with this crank angle. During the practice the starboard low pressure valve guide was broken by the slamming of the links, the reversing engines not having sufficient power to control their movements. After this practice we started ahead on the port engine and anchored off Giesborough Point, at 4.20 p. m. At 2.45 p. m. the following day we got under way and steamed up to the navy yard. Several mechanics from the Pusey and Jones Company's yard came around with the ship and were engaged in finishing up work in the engineer's department.

On the 15th of January we received Sigsbee's deep-sea sounding machine from the National Museum, where it had been on exhibition since its completion in July last.

On the 16th the starboard engine was worked from 1.45 to 2.30 p. m. under the direction of Mr. C. W. Copeland, the designer, and in the presence of Mr. C. W. Pusey, engineer of the Pusey and Jones Company, Passed Assistant Engineer G. W. Baird, U. S. N., and others. The reversing engines worked much better, but it was demonstrated to the satisfaction of Mr. Copeland that they had not sufficient power to move the valves promptly or to control their motion, and the order was then given for the construction of more powerful reversing engines, from designs furnished by Passed Assistant Engineer G. W. Baird. It was then decided that the vessel should return at once to Wilmington for this purpose as well as to change the crank angles from 145° to 90°.

We were detained by ice in the Potomac until February 10, during which time the general work of completing the ship, such as painting, finishing wiring of electric plant, and numerous details in the engineer's department, was carried on. At 9.45 a. m. on the latter date we left the navy-yard and arrived at the wharf of the Pusey and Jones Company, Wilmington, Del., at 6.20 p. m., February 13.

Work upon the contemplated alterations was commenced immediately and pushed forward with rapidity. All decks except those of the cabin, wardroom, and rooms in the deck-house were calked. On the 16th of March 4,000 fathoms of dredge rope were put upon the reel.

On March 21, the alterations being completed, we left the builders' yard at 10.30 a. m., and steamed down the Delaware, anchoring under the breakwater at 5.50 p. m. The new reversing engines were found to have sufficient power, which, combined with the advantageous change in the crank angle, enabled all signals to be answered with promptness and certainty. At 6.54 the following morning we got under way and stood to the southward and eastward, and at 3.20 p. m. sounded in 519 fathoms, the bottom being green mud. Put over the deep-sea trawl, veering to 820 fathoms on the dredge rope. At 5.11 it was landed on deck, containing several rare species of deep-sea fish. The current number of this haul is 2,001. The vessel remained hove-to from the time the trawl was landed on deck until midnight and then started ahead south-southwest, the wind blowing at the time a moderate gale from northwest. It moderated towards morning, and at 5.50 a. m. we sounded in 641 fathoms (haul 2,002) green mud, and at 6.05 put over the beam trawl, veering to 900 fathoms on the dredge rope. At 7.40 the trawl was landed on deck. The haul was successful; time going down 25 m., coming up 30 m.

Haul 2003: At 8.44 a. m. we sounded in 641 fathoms. The sounding wire parted while heaving in, resulting in the loss of the lead and thermometer. At 8.55 the beam trawl was put over and 950 fathoms veered on the dredge rope. At 10.46 the trawl was landed on deck with very little in the net, owing, probably, to its having failed to reach the bottom.

Haul 2004: At 11.10 a. m. we sounded in 102 fathoms green mud, broken shells, and put the trawl over at 11.17, veering to 208 fathoms. At 11.52 the trawl was up, containing a light load of star-fish, pole flounders, &c.

Haul 2005: At 11.52 a. m. sounded in 82 fathoms blue mud, sand, and broken shells. At 11.55 put over the beam trawl, veering to 100 fathoms. At 12.27 it was landed on deck, containing only a small marbled shark.

Haul 2006: At 12.58 p. m. we sounded in 512 fathoms blue mud, fine sand. At 1.10 put over the beam trawl, veering 800 fathoms. It came up at 2.11, foul and empty.

At 2.15 p. m. we started ahead full speed for Washington. Made Cape Charles light at 8.55 p. m., and Cape Henry at 9.38. The morning of the 24th opened with a fresh gale from northwest, moderating to-

wards evening. At 10.10 a. m. we passed Point Lookout and entered the Potomac River. At 3 p. m. we met the Fish Hawk bound down, and at 7.10 p. m. anchored for the night off Alexandria, Va. We got under way at 8.20 a. m. on the 25th and steamed to the navy-yard, Washington, D. C.

The sounding and dredging during the trip was for the purpose of testing the apparatus, which was found to work satisfactorily with the exception of a few matters of detail, which were easily remedied. Experiments were also made with the submarine electric light by Messrs. Moore and Britton of the Edison Company, who made the trip for the purpose. The apparatus consisted of three incandescent lamps fixed to a brass plate which formed the base of a double glass globe enveloping them. The lamp failed to act satisfactorily; water entering when it was lowered 200 feet. An ordinary 16-candle B lamp was used successfully at a depth of 150 feet, this being the length of its cable.

We remained at the navy-yard until April 24, making preparations for the season's work of deep-sea exploration. Boiler-makers were at work on the boilers most of the time while we were in port. In fact there has been more or less work on them whenever fires have been hauled.

At 8 a. m., on that date, we left for a cruise under the following orders, viz:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 10, 1883.

SIR: As soon as you can be ready for the service (of which you will give me a week's notice), you will go to sea for the purpose of investigating the conditions which govern the movements of the mackerel, menhaden, bluefish, and other migratory species along the coast of the United States in the spring, commencing your investigations off Hatteras, or in the region where these fish usually make their first appearance, and following up the schools in their movements.

The special work to be performed will be to determine the rate of progress of the fish along the coast, their comparative abundance and condition, the places where they first show themselves, the physical condition of their surroundings as to temperature and currents of the water, its chemical and biological peculiarities, &c.

You will endeavor to ascertain whether the appearance of the fish at or near the surface depends upon the condition of temperature, wind or sky, and also, by the use of the apparatus at your command, what character of food in the water seems to determine their movements You will cause examination to be made of the stomachs of such of these fish as you can capture and carefully preserve a portion at least of the contents of the stomach for immediate or future examination.

Should you deem it expedient you will cruise off the coast a sufficient distance to determine the outward line of motion of the fish, and you will communicate to such fishing vessels as you may meet any informa-

tion that may enable them the more sucessfully to prosecute their labors. The time of this work is left to your discretion. You will whenever you touch at any port of the United States send a telegram to me and await instructions as to further operations, if there be nothing to detain you.

You will give to the naturalist of the expedition all possible facilities for collecting and preserving such specimens as you may meet during the cruise.

Very respectfully,

SPENCER F. BAIRD,
Commissioner.

Capt. Z. L. TANNER,
Commanding Steamer Albatross.

P. S.—The operations of dredging and trawling should be carried on as frequently as opportunity offers; and if no suitable bait can be had, the trawling line should be used for the purpose of determining the currents of desirable fishing grounds.

At 5.45 p. m. we anchored for the night in Cornfield Harbor with the intention of swinging ship the next day for compass observations. At 5.45 the following morning we got under way and swung ship, first with starboard helm, then with port, observing azimuths on every point. She was then listed, first 5° to starboard, then 4½° to port, and azimuths taken on every other point for heeling error.

Lieutenants Wainwright and Diehl, U. S. N., were sent by the Bureau of Navigation, Navy Department, to make magnetic observations. They assisted in swinging ship, and at 11 a. m. went on shore to vibrate the vertical and horizontal needles. After completeing observations for heeling error, the needles were vibrated in the standard binnacle, the compass being unshipped for the purpose. The latter observations were continued after dark, light being furnished by an ordinary 16-candle B electric lamp attached to a flexible wire. Experiments were made as to its effect upon the compass and the delicate magnetic needles, but they were not perceptibly affected. The magnetic observations were completed about 8 p. m., when we started for Fort Monroe to land Lieutenants Wainwright and Diehl, who were to return to Washington. The vessel was put under low speed and arrived at 5.45 a. m., April 26, when the officers were landed and the steward sent to market; and at 8 a. m. we got under way and proceeded to sea. After passing Cape Henry we stood to the southward, parallel with the coast, keeping a careful lookout at the mast-head and on deck for schooling fish, but none were seen, although the weather was clear and pleasant with light winds and smooth sea.

We made Hatteras light at 10.20 p. m., and hove to for the night, drifting slowly off shore. The search for mackerel was resumed in the morning and two hauls of the trawl were made during the day, one only being successful; the trawl fouling a wreck or other obstruction on the bottom during the second haul, it was lost with eighty five

fathoms of rope. Several soundings were taken with the Sigsbee machine, and towards evening we steamed in shore heaving to finally to the eastward of Hatteras light, where mackerel would be most likely to appear if passing the cape.

We stood off shore again on the morning of the 28th and made two attempts to work the trawl in the Gulf stream. In the first instance it came up foul, and in the second the trawl was lost, only a few fathoms of rope being lost with it. After cruising actively during the day we stood inshore towards evening, and at 8.30 p. m. hove to off Bodies Island light. While in the Gulf stream to-day large numbers of black fish and porpoises were seen about the ship. The weather was clear and pleasant with light southwest wind. No indications of mackerel.

On Sunday morning, April 29, we stood inshore and hove to for several hours, then steamed off shore. The weather was clear during the early part of the day but clouded over about noon, and at 2 p. m. we had a thunder squall from southwest, the wind shifting to northwest and northnortheast blowing a moderate gale during the night with heavy swell. The vessel behaved well and her motions were remarkably easy. No indications of schooling fish.

We hove to till daylight the following morning, then steamed off shore and made three casts of trawl and dredge. The trawl and 1,380 fathoms of dredge rope were lost on the last haul, the accident being caused by the dredge block at the boom end giving away. Water specimens and serial temperatures were taken in about 700 fathoms. No schooling fish were seen during the day. A temporary dredge block was fitted and, although not suitable for the work, we managed to use it.

The weather cleared during the day and the wind moderated, but there was still a heavy easterly swell. The vessel was hove to for the night.

The submarine lamp was lowered during the evening and the lights extinguished at about 100 feet below the surface. After being lowered 600 feet and hauled up there was nothing remaining but the metal frame.

On May 1 the weather was clear during the morning, clouding up later in the day. At 6.35 a. m. we cast the trawl in 375 fathoms, making a successful haul although we did not accomplish it without accident. The makeshift dredge block was unfitted for its work, causing an injury to the rope which made it necessary to cut and splice it. This occupied most of the day. At 7 p. m. we steamed ahead for Cape Henry, making the light at 12.35 a. m. We then stood to the northward, passing as close in as prudent. A fresh northeaster was blowing and a heavy sea running, making it undvisable to get into less than 7 or 8 fathoms.

About 6 miles to the eastward of Hog Island light we passed a vessel's mast, the mast-head showing above water. It was apparently fast

to a wreck. Large quantities of drift fire-wood were seen during the morning, probably a vessel's deck-load.

We stood on slowly to the northward as far as the light on Winter-Quarter Shoal, then stood off and on during the night. A thick fog set in at dark. No fish were seen during the day.

May 3 opened with a fresh breeze from northeast, heavy easterly swell and a dense fog. We stood off and on between the light-ship and Fenwick's Island during the day, but saw no fish nor fishermen. The fleet of mackerel fishermen were due in this region, and in order to ascertain their whereabouts we started ahead, and at midnight stood in for Cape Henlopen, sighting it about 7 a. m., the fog having lifted for a short time. At 8 a. m. we boarded the fishing schooner, M. B. Tower, of Portland, Me., which had just arrived on the station. Captain Blake said that he had seen neither fish nor fishing fleet, and would like to know where either or both were.

After parting company with the schooner we ran 30 miles southeast and found vessel after vessel looming up out of the fog. The M. E. Torrey, of Sedgwick, and the Starry Flag, of Gloucester, were boarded. They had taken no fish and had seen none, having just arrived from Sandy Hook. There were they said about 125 schooners farther to the southward.

The weather was somewhat clearer during the afternoon, and, wishing to see what the fleet were doing, we steamed to the southward till 7 p. m., gradually overhauling and passing many vessels. The fog shut down again about dark, and, not wishing to miss the fleet, we hove to for the night. Our steam whistle, which was sounded frequently, and the fog horns of the fishing fleet made a most doleful concert. No mackerel had been seen as yet.

The fog continued on the 5th and there was still quite a swell from the eastward. Schooners were passing us frequently, standing to the southward. During the morning we took three casts of the trawl and rake-dredge in shoal water and then steamed slowly to the southward, watching the movements of such vessels as we sighted in the fog. As no fish had been seen here I determined to stand to the southward and see if we could find them in that region. With this object in view we started at 11 a. m. and steamed to latitude 36° 30′ N., but saw no fish. We then turned to the northward running off and on shore, intending to intercept the fishing fleet in the morning.

The fog continued throughout the day and until about 9 a. m. on the 6th, when it broke away, revealing several fishing schooners, and soon after we saw our first school of mackerel, in latitude 37° 03′ N., longitude 74° 54′ W. They were small fish, and, on speaking the Richard K. Fox soon after, he informed us that he had seen the same school. We then steamed to the southward and westward till 2 p. m., then southeast to latitude 36° N., but saw no indications of mackerel, after leaving the fishing fleet. At 7 p. m. we changed our course to the northward,

standing off and on toward the fleet, which was sighted at daylight on the morning of the 7th. At 6 a. m., in latitude 37° 03′ N., longitude 75° 03′ W., we sighted several schools of mackerel, most of them being small fish. There were but three or four seines out from a fleet of upwards of 60 vessels in sight at one time.

Having fairly struck the schools in shore, we ran 35 miles to the eastward to ascertain how far they extended seaward. No fish were seen, however, after leaving the locality where we saw them in the morning.

Being in about 800 fathoms at the end of this run we took the opportunity to try the trawl again, and made one very successful haul During the second one, however, we lost the trawl and 10 or 15 fathoms of dredge rope. The accident was the result of kinking and the fault rests between myself and the dredge rope. I have not yet been able to judge satisfactorily which is responsible for the frequent losses during our present trip.

At 6.40 p. m. we started in shore, and at 11 p. m. hove to 5 miles to the northward of the spot where mackerel were seen in the morning, but neither fish nor fishermen were visible. The weather continued clear and pleasant during the night, and at daylight on the 8th there was a moderate breeze from south. We then ran in shore, sighting Cape Charles and Hog Island lights, and when within 12 miles of the latter turned our head off shore steering east-northeast until 10.45 a. m., when, in latitude 37° 22′ N., longitude 75° 15′ W., we ran into numerous schools of mackerel; many of them were, however, small fish. We put the large towing net over and steamed through several schools, hoping to catch some of the small fish upon which they were feeding. Two specimens only were taken and carefully preserved in alcohol. We tried a gill net for mackerel, thinking we might get a stray fish, but they promptly dove under it whenever they encountered it.

The fishing fleet were not in sight, and wishing to ascertain their whereabouts, we ran 15 miles to the eastward to a point about 18 miles north of the position of the fleet yesterday morning, but neither fishermen nor fish were to be seen. The time had now arrived when it was necessary to return to port for coal, and our head was accordingly turned towards Cape Henry, between 50 and 60 miles to the southward and westward. At 9 p. m. we anchored in Hampton Roads.

At 8.30 a. m. the following day, May 9, we got under way and steamed to the navy-yard, Norfolk, Va., for coal and repairs to boilers and machinery. We finished coaling on the 12th, necessary repairs detaining us until 3.55 p. m. on the 18th, when we left the yard, and, passing the Capes, stood to the eastward, intending to spend the following day in the use of trawl and dredge.

The weather was calm and clear during the evening, but there were indications of wind which, in fact, we got before morning. A line of soundings was taken on the way out to fill a gap on the coast chart. A good lookout was kept also for mackerel and menhaden, but none

were seen. Before arriving on our intended dredging ground it was blowing a moderate gale from northeast, with heavy sea—too rough for our work. The vessel was therefore put head to wind and sea under easy steam until 2 a. m. on the 20th, then put before it, running back to our station by daylight. The wind had moderated in the mean while, but a heavy easterly swell was still rolling in. Later in the day quite a large number of soundings were taken which will be useful in filling gaps on the chart. Porpoises were frequently seen about the ship. The weather was still unsettled and the barometer very low, a dense fog prevailing at intervals.

During the 21st several successful hauls of the trawl were taken. The fog continued with an occasional interval of clear weather. At 5.40 p. m. we steamed ahead for the purpose of making an examination of the coast for schooling fish or fishermen. We passed Barnegat about 10 a. m. on the 22d, and steamed along the coast to Sandy Hook, getting sight of land occasionally as the fog lifted. No schooling fish nor fishing vessels were seen. The barometer was still low, 29.57, and the weather unsettled. Leaving the Hook, we steamed along the southern shore of Long Island during the night, passing Block Island at 8 a. m. on the morning of the 23d. Several fishing schooners were seen in the harbor, but none outside. A heavy southerly swell and thick fog with low barometer induced me to run into Newport, R. I., for a harbor to save coal.

The weather having improved we got under way at 10.40 a. m. on the 24th and ran over to Montauk Point, thence to Block Island and No Man's Land, keeping a good lookout for schools of fish, but saw none. There were several fishing schooners in Newport, and we met quite a number standing in as we were going out. A dozen or more were standing off and on to the southward of Block Island, and occasionally one was seen farther to the eastward, as far even as No Man's Land. There were a large number in the harbor at Block Island, the bad weather of the last few days having probably driven them in there for shelter. From No Man's Land we stood to the southward under very low speed for two hours, during which the arc light was hung over the side near the water to attract fish. We succeeded in drawing quite a number of Mother Carey's chickens around us, and attracted so many salpa to the surface that Mr. Benedict gave up surface towing, saying that he could get nothing else in his net.

I have been anxious to see the effect of this brilliant light on a school of mackerel, but, unfortunately, we have fallen in with none at night. The light was finally taken in and the speed increased to bring us to the lopholatilus ground at daylight. We succeeded in getting a barrel of bait in Newport and proposed setting a trawl line on our best ground for tilefish.

The morning of the 25th opened clear and pleasant with light to moderate breeze from southwest. At 5.15 a. m. we lowered the dinghy

in latitude 40° 05′ 25″ N., longitude 70° 28′ W., in 90 fathoms of water, with instructions to set the trawl line north and south, which would bring the southern end in something over 100 fathoms. In the mean time we steamed a few miles to the southward and commenced dredging on our old ground, where we recognized the endless variety of forms which we had taken in former years. At 10.30 a. m. we took the fishermen on board and hoisted the dinghy. They had taken large numbers of dogfish, hake, skate, &c., but no tilefish. Dredging was continued for a while longer in this locality and then we ran to the southward and westward, finally casting the lead in 1,168 fathoms, latitude 39° 42′ N. longitude 70° 47′ W. A set of serial temperatures and water specimens from various depths was taken, and finally the dredge and tangles were put over. They came up about midnight filled with a compact mass of gray ooze and a most tenacious mud or clay which proved to be very rich in foraminifera, about three quarts having been procured from it. The water specimens were carefully preserved for future examination. The combination of incandescent and arc lights was brought into use illuminating the deck and surroundings so perfectly that work was carried on almost as well as in daytime.

As soon as the dredge was up, we steamed to the southward and westward again, and at 6.20 a. m. the following day cast the trawl in latitude 39° 29′ 45″ N., longitude 71° 43′ W., depth 588 fathoms. This was a very successful haul, bringing up great numbers of large red crabs and several fish which were not recognized by us. We attempted to keep some of the former alive in a large tub of water, but they all died within twenty-four hours. After the trawl came up we stood to the westward toward the 145-fathom hole of the Coast Survey charts. Occasional casts of the lead were taken in depths of from 301 to 363 fathoms in the hole. We then stood to the southward about two and a half miles and set the trawl line in 74 fathoms, latitude 39° 29′ N., longitude 72° 19′ 55″ W., and while the fishermen were away we cast the trawl twice, taking several varieties of fish, star-fish and other forms found in that depth.

After taking up the line, the dinghy returned to the ship with large num bers of dogfish, hake, skate, and two kingfish but no tilefish. We returned to the hole above mentioned after hoisting the boat and cast the lead in 379 fathoms, took a set of serial temperatures, which are worthy of notice, the alternating cold and warm strata showing a most peculiar condition of currents, which may perhaps furnish a clew to the formation of the "hole." A specimen of bottom water was taken also for future examination. The beam trawl was lowered and an interesting haul anticipated, but the light net was not strong enough to bring up the load of mud collected and was torn from the frame.

I am not fully satisfied with our hurried examination of the interesting spot, and trust that we may have an opportunity at some future time to make a more thorough exploration.

The weather was threatening during the afternoon, with falling barometer, and by the time we had finished our observations it was blowing a fresh breeze from southwest with quite a heavy swell. At 7.40 p. m. we started for New York, where we arrived at 9.33 a. m. on the 27th, and anchored off the Battery, where we found the following vessels of the North Atlantic squadron at anchor, viz, the flag-ship Tennessee and ships Vandalia, Kearsarge, and Yantic. The Minnesota and Saratoga were off Twenty-third street, North River.

At 6.20 p. m. the following day we got underway and steamed up to the navy-yard, and at 7.45 a. m. May 31, went into the dry-dock to have the ship's bottom cleaned and painted.

Lieutenants Wainwright and Diehl reported on board June 1, by order of the chief of Bureau of Navigation, to continue the magnetic survey while the vessel was in dock, and, having completed their work, they left on the 3d for Washington.

We hauled out of dry-dock on June 6, coaled ship on the 7th and 8th, and were engaged in the general work of overhauling, painting, &c., until 7 a. m., June 17, when we left the yard for Washington, D. C., where we arrived at 8 a. m. on the 19th, and were employed making general preparations for the season's work until 10 a. m., July 6, when we left the yard and steamed down the Potomac under the following orders:

U. S. Commission of Fish and Fisheries,
Washington, D. C., June 26, 1883.

Sir: As soon as the Albatross is in condition for leaving the Washington Navy-yard, you will proceed to sea, taking on board Capt. Jacob Almy, of New Bedford, as fisherman expert.

Your object will be to obtain as much information as possible in regard to the movements of the mackerel, menhaden, and other sea fishes, determining, as far as possible, their numbers, size of schools, distances of the schools apart from each other, the range of the species in latitude and longitude, the conditions which affect them, especially those of temperature at the surface and below, the food, condition of the sky, &c.

You will give Captain Almy every opportunity to test practical questions in this connection, and instruct him to use the net and other fishery apparatus on board in ascertaining the whereabouts and numbers of fish when they do not show at the surface, taking samples for identification whenever practicable.

As soon as you have been out sufficiently long to make a satisfactory investigation, you will report at Wood's Holl, Mass., for further duty.

Very respectfully, yours,

SPENCER F. BAIRD,
Commissioner.

Capt. Z. L. Tanner,
Commanding Albatross, Navy-Yard, Washington, D. C.

At 9.25 p. m. we anchored in the Chesapeake between Smith's Point and Wicomico River, and the following morning sent Capt. Jacob Almy in the steam-cutter to board such fishing vessels as he considered advisable out of a fleet of between sixty and seventy schooners engaged in taking menhaden at that point. We worked to the southward, boarding such fishing vessels as came in our way until we reached Mob Jack Bay, where an extensive fish factory was visited and much information obtained. We then went to Hampton Roads for a harbor.

At 4.15 a. m., on the 8th, we got under way and proceeded to sea. Having passed the Capes, we stood to the northward, as near the coast as practicable, keeping a lookout for schooling fish or fishing vessels. Large schools of menhaden were seen off Hog Island, but no fishermen, and we saw no fish between this point and the Delaware Breakwater except porpoises, which were about the ship in large numbers during the afternoon. At 8 p. m. we anchored at the breakwater for the night.

The weather, which had been delightful throughout the day, changed in the evening and was squally and unsettled during the night. The following morning the fishing vessels and fish factories in the vicinity were visited, and at 1 p. m. we got under way and stood to the northward, keeping a lookout for fish and fishing vessels, but saw neither until in the vicinity of Sandy Hook. Several vessels were boarded in the Lower Bay, and the fish factories at Port Monmouth visited by Captain Almy. A large number of vessels, both sail and steam, were fishing in the Lower Bay. At 11.10 a. m. we left Sandy Hook and steamed along the Long Island shore. Occasional schools of menhaden were seen as we approached Fire Island, where several fishing vessels were at work. The schooner Mary Wood was boarded at this point. Occasional schools were seen as far as Shinnecock, but none between that point and Montauk.

At 8.25 a. m., July 11, we anchored off Greenport, Long Island, and the fish factories in that vicinity were visited. We then went to Promised Land, Napeague Bay, Long Island, where several factories were visited by Captain Almy.

At 4 a. m., July 12, got under way and steamed up Long Island Sound, calling at various factories, finally anchoring for the night off Throgg's Neck. Menhaden fishermen were seen at work as far west as New Haven. Nine steamers were seen at one time during the day.

We were under way at 7.30 a. m. on the 13th, running to the eastward through the Sound. Several fishing vessels were boarded during the day, and the extensive factory of Luce Brothers at Niantic, Conn., was visited. We then stood to the eastward under low speed, keeping a lookout for fish during the night, but none were seen. At daylight, on the morning of the 14th, we were near Gay Head, and at 6.35 anchored in Wood's Holl.

The reports obtained from fishing vessels and factories by Capt. Jacob Almy are appended. To save time a list of questions was pre-

pared and numbered, the number and answer only being written by the boarding officer; this rule was followed on board of fishing vessels, but at the factories he has adopted the narrative form, which I have retained.

It will be observed, by reference to the reports, that menhaden are unusually plentiful this season from the Chesapeake to Montauk, the ground covered by our investigation. It will be seen, also, that the fish are generally below the average in size and condition, the product varying from one to two gallons of oil to a thousand fish.

The fishermen of the Chesapeake whom we interviewed were unanimous in their belief that the menhaden taken there were a local fish, that they spawned in the bay, and remained there through the winter. Some of them report having seen full-grown menhaden in winter, and large masses of young fish. The Fish Hawk took menhaden from 3 to 6 inches in length early in March, 1882, in the Chesapeake, which would seem to favor the theory that they wintered there.

We saw no fishing outside of the capes of the Chesapeake and none inside the Delaware capes. In the latter case their fishing grounds extend from Fenwick's Island to Hereford light. The tides are too strong inside the capes to use the purse-seine with success.

The New York grounds may be said to extend from Barnegat to Fire Island, large numbers being taken in the Lower Bay. Vessels to the eastward of Fire Island usually deliver their catch to factories in Long Island Sound, and fish taken in the Sound are delivered to factories in the vicinity. It would seem by the report that very few edible fish are taken with the menhaden. The quantity varies, however, in different localities.

The first catch of the season is from the pounds before they begin schooling at the surface. There were no mackerel reported between the Chesapeake and Montauk, the invariable reply to the question being that they had gone to the eastward.

It is well understood among fishermen that the temperature of the water has a marked effect upon the movements of menhaden, but there seemed to be very little knowledge as to the actual temperatures required to produce certain results. Some observers, however, stated that they did not school at the surface until the water was about 54°. Clear weather with south and west winds was considered the best for fishing.

Opinions differ somewhat, it will be observed, as to increase or decrease of fish on the Atlantic coast.

On July 7, off the mouth of the Great Wicomico River, in a fleet of about sixty sail, the following questions were asked by Captain Almy, viz:

1. What vessel is this?
2. Whence does she hail?
3. What is the captain's name?

4. Have you seen or taken any fish?
5. What kind?
6. When and where were mackerel and menhaden first seen this season?
7. How fast do schools travel north?
8. In what depths of water are they most likely to be encountered?
9. Any other information that would be of interest?
10. How many menhaden have you caught so far this season?
11. What was your last year's catch?
12. How many fish have you had at your factory so far this year?
13. What is the name of the firm for which you sail?
14. Do you know how many fish were taken for the factory last year?
15. What are the dimensions and size of mesh of your seine?
16. How long do seines last in this climate?
17. Do you catch any other fish among the menhaden?
18. How many men do you carry in your gang?
19. What state of the weather is best for fish to be seen in?
20. How far up the bay do these fish go?
21. Where do menhaden winter?
22. What do they eat?
23. What effect does change of temperature of air or water have upon them?
24. Is their arrival or departure affected by temperature of water?
25. Can you suggest any improvement upon the present method of taking menhaden?

The captain of the first fishing vessel boarded made the following replies, viz:

1. Lizzie Bell.
2. Baltimore.
3. George Ketchum.
4. Yes.
5. Menhaden.
6. 15th of April; schooling May 1; Chesapeake Bay.
7. They remain here and spawn.
8. From 4 to 6 fathoms.
10. Four hundred thousand.
11. Eight hundred thousand.
12. One and a half millions; we work three gangs.
13. G. T. Burgess.
14. No; light catch.
15. Length, 100 fathoms.
16. Six months.
17. Yes; Spanish mackerel.
18. Nine.
19. Southerly winds.

The following replies were made by the captain of the next one boarded, viz:

1. General Carmichel.
2. Town Creek, Md.
3. N. A. Haynie.
4. Yes.
5. Menhaden.
6. 15th June; Chesapeake Bay.
7. They are local and I do not think they leave the bay.
8. From 4 to 10 fathoms.
9. None.
10. Sixty thousand.
11. Two millions.
12. Do not know.
13. Marsh, Booth & Co.
14. Two millions.
15. Length, 120 fathoms; mesh, 2 inches.
16. One year.
17. Yes; some tailors and greenfish.
18. Nine men.
19. Southwest weather; clear.

The captain on board the next one replied as follows, viz:

1. Louisa A. Muir.
2. Baltimore.
3. L. J. Beatley.
4. Yes.
5. Menhaden.
6. 15th April; Chesapeake Bay.
7. They do not go north, but spawn here.
8. From 4 to 10 fathoms.
9. None.
10. Fifteen hundred thousand.
11. Thirteen hundred thousand.
12. Six millions.
13. E. W. Reed & Son.
14. Forty-four hundred thousand.
15. Length, 80 fathoms; mesh, 2 inches.
16. Scarce one season.
17. Yes; a few tailors.
18. Nine men.
19. Southerly weather.

On board the next one replies were made by the captain as follows, viz:

1. Schooner Dager.
2. Tappahannock.
3. A. Tason.

4. Yes.
5. Menhaden; very small.
6. 15th of April; Chesapeake Bay.
7. They are local, spawning here.
8. From 5 to 10 fathoms of water.
9. None.
10. Two millions.
11. Twenty-eight hundred thousand.
12. One and a half millions.
13. N. H. Timbs.
14. No.
15. Length, 100 fathoms.
16. One year.
17. Very seldom.
18. Nine men.
19. Southerly and easterly.

The captain of the next one boarded replied as follows, viz:

1. Harriet Howarth.
2. Crissvesse, Md.
3. J. H. Crowder.
4. Yes.
5. Small menhaden.
6. 9th of May; Chesapeake Bay; no mackerel seen.
7. They are local, spawning here.
8. From 3 to 6 fathoms.
9. None.
10. Two millions.
11. Do not know.
12. Nine millions.
13. E. W. Reed & Son.
14. Six millions.
15. Length, 122 fathoms.
16. One season.
17. Very few; some tailors, known in New York as bluefish.
18. Nine men.
19. Southerly.

Off Rappahannock Spit, on the same date, boarded the following fishing schooners, and, asking the same questions as above, elicited the following replies, viz:

1. Stephen Hopkins.
2. Baltimore.
3. Alvin George.
4. Yes.
5. Menhaden.
6. 1st of May; Chesapeake Bay.
7. Twenty miles a day.

8. Without regard to depths.
9. Menhaden spawn here.
10. Twelve hundred thousand.
11. Twelve hundred thousand.
12. Two millions; we work two gangs.
13. James & Co.
14. Four millions.
15. Length, 120 fathoms.
16. Two years.
17. Yes; some bluefish.
18. Nine men.
19. Southerly.
20. As far as Annapolis.

Answer on board the next one:

1. Schooner Ostrich.
2. Crisfield, Md.
3. C. E. Ketchum.
4. Yes.
5. Menhaden.
6. In March; in Chesapeake Bay.
7. Fifty miles a day, when outside the capes.
8. From two to five fathoms.
9. Menhaden spawn from Massachusetts to Florida.
10. One million.
11. Did not fish.
12. Five millions.
13. W. D. Hall & Co.
14. Seven millions.
15. Length, 120 fathoms.
16. One season.
17. Yes; a few bluefish.
18. Nine men.
19. Very little difference.
20. As far as Pool's Island.

"The fattest fish known to be caught gave 12 gallons of oil to the thousand. The present value of 1,000 fish is $1.90. I know these fish to be local; they do not leave this place. We are making at present two gallons of oil to the thousand."

Answers on board the next one visited:

1. Schooner Prowess.
2. Crisfield, Md.
3. A. R. McNamara.
4. Yes.
5. Menhaden.
6. Tenth May; Chesapeake Bay.
7. Depending upon circumstances.

8. From 2 to 10 fathoms.
9. No.
10. Thirteen hundred thousand.
11. Thirteen hundred and forty-seven thousand.
12. Twenty-eight hundred.
13. James & Co.
14. Four millions.
15. Length, 116 fathoms.
16. One season.
17. Yes; a few bluefish and some Spanish mackerel.
18. Nine men.
19. Southerly.
20. As far as the Patuxent River.

Answers on board the next one visited off Rappahannock Spit:

1. Thomas Bell.
2. Baltimore.
3. George P. Squires, post-office address, Whitestone, Va.
4. Yes.
5. Very small menhaden.
6. Fifteenth of April; Chesapeake Bay.
7. Ten miles an hour outside the capes.
8. From five to seven fathoms.
9. The most fish of this class I have seen for years.
10. Twenty-three hundred thousand.
11. Fifteen hundred thousand.
12. Fifty-three hundred thousand, working three gangs.
13. Bellows, Rasquith, Squires & Co.
14. Thirty-seven hundred thousand.
15. Length, 115 fathoms.
16. One season.
17. Yes; occasionally tailors.
18. Eleven men.
19. Easterly.
20. As far as Baltimore.

"When approaching the coast, fish move very slowly; when leaving, very rapidly. Large fish full of ripe spawn were seen on the 10th of October in the mouth of the Rappahannock River."

Answers on board the next one visited off Rappahannock Spit:

1. Schooner Annie.
2. Rappahannock.
3. Edward Sommers.
4. Yes.
5. Very small menhaden.
6. First of May; Chesapeake Bay.
7. Do not know.
8. From 8 to 10 fathoms.

9. None.
10. Eight hundred thousand.
11. One and a half millions.
12. Eighteen hundred thousand.
13. L. H. Irvin & Co.
14. Eight hundred thousand.
15. Length, 115 fathoms.
16. One season.
17. Yes; a few tailors.
18. Ten men.
19. There is no difference.
20. As far as Baltimore.

On the same date, July 7, 1883, Captain Almy visited the menhaden factory of Mr. R. T. Bosman, in Mob Jack Bay, who made the following statement, viz:

"These works were built sixteen years ago, and since then have been in constant operation. Menhaden were formerly very plentiful, but there has been a gradual falling off until the present season. They are now more plentiful than at any time during the past seven years. Two and sometimes three gangs are employed, the average catch being two millions by each gang. The fish make their appearance about the 1st of April, remaining till the latter part of November. I have seen full-grown fish in the bay in winter, and great masses of young fish also; the latter I am confident remain in the bay. I have seen fish taken in November which had just spawned. Five years ago great numbers of young menhaden were driven on the shore by a northeast gale. There are numerous stake-traps here (Mob Jack Bay) catching in their season shad, alewives, hickory shad, weakfish, Spanish mackerel, sheep's-head, pogies, &c. There has been a general decrease from year to year in the quantity of fish taken in the traps. The greatest falling off is in Spanish mackerel, sheep's-head, and weakfish; shad hold their own better than any other fish. Whales are sometimes seen ten miles or more inside the capes, and porpoises come in about the 1st of April, remaining till November. The average yield of oil is about 2½ gallons for 1,000 fish. The scrap is sun-dried, this establishment using no sulphuric acid.

"There are numerous factories in the Chesapeake, one in Back River, one at Cherry Point, and two on Piankatank River. The Back River works is one of the largest in the Bay, running ten gangs, and using 20,000,000 fish annually, the other works using about two millions on the average. The fishermen of the Chesapeake are in high spirits over the abundance of menhaden found in the bay this season."

On July 9, at the Delaware Breakwater, the following replies were received upon boarding fishing vessels, viz:

1. Sloop J. W. Luce.
2. New London.

3. W. F. Saunders.
4. Yes; take them every pleasant day.
5. Small menhaden.
6. From 10th March to 1st April; off Cape Henry.
7. 20 miles in 24 hours.
8. Ten fathoms.
9. Mackerel do not approach the coast so near as menhaden.
10. Two hundred thousand.
11. They did not run last year.
12. One and a half millions.
13. Luce Brothers.
14. Twenty millions.
15. Length, 130 fathoms.
16. One season.
17. Very seldom.
18. Twenty men.
19. Moderate southerly and westerly winds.
20. To the head of navigation.

"I think that the habits of fish are similar to those of birds which go north in summer and return south in winter. I have not seen so many mendaden on the coast before in seven years, and have noticed that the small ones appear in about this interval."

Answers on board the next one:

1. Steamer G. S. Allen.
2. Wilmington, Del.
3. William Spicer.
4. Yes; I take them every day when the weather is favorable.
5. Mendaden of small size.
6. On 15th April, off Delaware Breakwater; as for mackerel, I do not know.
7. Twenty miles in twenty-four hours.
8. From one to fifty fathoms.
9. Sharks are seen in great abundance in this locality.
10. Seventeen hundred thousand.
11. Forty-four hundred thousand.
12. Do not know.
13. Brown & Lennon.
14. This is my first season.
15. Length, 170 fathoms; mesh, 2¼ inches.
16. If used steadily three months.
17. Very few; sometimes small bluefish.
18. One gang of fourteen men.
19. Moderate southwest winds.
20. To the head of navigation.

"There are two factories at the Delaware Breakwater, employing three steamers and one sailing gang, fishing six seines."

Answers on board the next one visited:

1. Steamer Quickstep.
2. New London, Conn.
3. F. H. Beckwith.
4. Yes; take them every day.
5. Small menhaden.
6. On 26th of April, both mackerel and menhaden; mackerel off Cape Henry; menhaden off capes of the Delaware.
7. About 25 miles in 24 hours.
8. Shoal water in the spring; deep water in the fall.
9. Sharks are very troublesome to us, and are seen in plenty.
10. Thirty-five hundred thousand.
11. Seven millions.
12. Fifteen hundred thousand.
13. Luce Brothers.
14. New factory; first season.
15. Length, 160 fathoms; mesh, $2\frac{1}{4}$ inches.
16. One season.
17. Very seldom; sometimes small bluefish.
18. Twenty-six men; two gangs.
19. Southerly and westerly.
20. As far as Reedy Island.

"The fishing-ground is outside of the Capes. There is too much tide inside for purse-fishing. Mackerel sharks are most common, but some sand sharks are seen here. The most common food-fishes caught here are weakfish caught in stake-traps, and shad in nets."

Answers on board the next one visited:

1. Steamer Samuel S. Brown.
2. Mystic, Conn.
3. James Linen.
4. Yes; take them every pleasant day.
5. Small menhaden.
6. On 10th May; mackerel at Cape Hatteras; menhaden at Cape Henry.
7. Nine miles in twenty-four hours.
8. From 4 to 10 fathoms.
9. Small and large fish do not as a rule run together.
10. Two and a half millions.
11. Four millions.
12. Eight hundred thousand.
13. S. S. Brown & Co.
14. New this season.
15. Length, 160 fathoms.
16. One season.
17. Very few.
18. Twenty-five men; two gangs.

19. Moderate southerly winds.
20. To the head of navigation.

"Our fishing-ground is from Fenwick's Shoal to Hereford light. There are very few fish caught inside Cape Henlopen, the strong tide preventing. Sharks are very numerous and troublesome; they are of the sand and mackerel species. At present, fish are more plentiful than I have seen them for twenty years."

The two menhaden factories at the breakwater are new, having been put up the present season.

On July 10, off Sandy Hook, the following replies were received upon boarding a fisherman, viz:

1. Sloop Mary E.
2. Greenport, N. Y.
3. W. Downs.
4. Yes.
5. Small menhaden.
6. Tenth of May; off Sandy Hook and the Highlands.
7. About 10 miles in 24 hours.
8. From 7 to 9 fathoms.
9. There are no sharks here.
10. Eight hundred thousand.
11. Two million.
12. Four millions.
13. Daniel Vail.
14. Six millions.
15. Length, 150 fathoms; mesh, 2½ inches.
16. One season.
17. None of consequence.
18. Nine men.
19. Southerly and westerly weather.
20. Amboy.

On the same date Captain Almy visited three factories that were in operation at Port Monmouth, N. J. The first one visited was owned by Daniel Vail, who made the following statement, viz:

"We have been in operation one year and employ three gangs. We have caught this year up to date 3,500,000 fish. The total catch last year was 4,000,000. The first fish this season were received on April 24, and were caught in a pound. The first fish caught in a purse seine were taken on the 16th of May. The average amount of oil realized was one gallon to the thousand. The bay fish leave here about the 20th of October. The other fish caught are those working to the southward through the sound. About 50,000 menhaden are used daily for bluefish bait. Very few edible fish are taken with the menhaden. The principal food-fishes taken in this locality are weakfish, bluefish, round mackerel, shad, and butter fish. I have not noticed any scarcity of food-fishes in the last twenty years. I believe that the fish make their

appearance earlier in the spring after a warm winter. Within a radius of 1 mile of this place are four factories in operation. No steamers are employed, sailing gangs being used altogether. I consider westerly winds most favorable for taking fish."

The next one visited was that of Mr. D. F. Vail, whose foreman made the following statement, viz:

"This factory has run continuously for the last sixteen years, employing at present three gangs. We have caught up to date this season about 2,000,000. The total catch last season was 3,000,000. On the 29th of April the first menhaden was caught in traps. On the 17th of May the first one was caught in a purse-seine. The average this year is 1½ gallons of oil to the thousand. We closed last year on the 1st of October. The best fishing is during the months of June and July. The greatest amount of fish ever received was 7,000,000 in a season. Five years ago, fishing was much better than it was last year."

The next one visited was that of Osborn & Sons, whose foreman made the following statement, viz: "This factory has been in operation continuously for four years, employing three sailing gangs, who have caught up to date, this season, one and a half millions of menhaden. The total catch last year was 5,000,000. The first fish this season, caught in a purse-seine, were received at the factory on the 25th of May. The average yield of oil is 1½ gallons to the thousand. Last year we closed on the 10th of November. No fish were caught in this bay after that date. There are more fish of all kinds here this year than have been seen in the last seven years. This statement applies also to the local food-fishes. Southerly and westerly winds are most favorable for catching fish. Northeast winds drive them to sea. After a northeast blow, fish are not caught again until westerly weather prevails. I have noticed three separate runs of fish, viz, one in May, another the latter part of June, and another in September. After a severe winter, shad are not so plenty. Bluefish are more numerous off the Hook this year than for several years past; weakfish are also very numerous.

On the same date, off Fire Island, the following answers were received upon boarding a fisherman, viz:

1. Schooner Mary Woods.
2. New York.
3. Charles Yarington.
4. Yes.
5. Large menhaden.
6. 15th of May; off Jersey beach.
7. Sometimes 2 miles, sometimes 10.
8. About 7 fathoms.
9. These answers apply to menhaden; know nothing of mackerel.
10. Five hundred thousand.
11. Twenty-four hundred thousand.
12 Five hundred thousand.

13. Smith, Yarington & Co.
14. Twenty-six hundred thousand.
15. Length, 170 fathoms; mesh, $2\frac{1}{2}$ inches.
16. Two years.
17. Very few; not enough for the crew to eat.
18. Twelve men.

We saw numerous schools of menhaden off Fire Island light, and continued to see them at intervals till dark. The last run was seen off Shinnecock light-house.

The first factory visited on the morning of July 11 was that of the Atlantic and Virginia Fertilizing Company, located at Long Beach, Long Island. The superintendent, S. H. Doran, made the following statement, viz:

"These works have been in operation for twenty-three years, and employ one fishing steamer. We have caught up to date this season 1,050,000 fish. The catch last year was 1,400,000. The first fish was caught in a purse-seine on May 19. The average of oil to a thousand fish is $1\frac{1}{2}$ gallons. They are small fish. We closed last year on the 15th of November. We catch very few edible fish among the menhaden. Southerly and westerly winds are most favorable. Fish scatter apart in warm weather and school together when the weather becomes cooler. Mackerel arrive on the south side of Long Island about the middle of May. We do not catch any mackerel after the 15th of June. The most extensive part of the business done here is the manufacture of fertilizers. The scrap furnishes ammonia, rock phosphate, the phosphate of lime and phosphoric acid when treated with sulphuric acid."

The next one visited was the Peconic Oil Works, Corwin & Cartwright proprietors, located at Shelter Island, Long Island. The foreman, Mr. W. M. Jennings, made the following statement, viz:

"These works have been in constant operation for fifteen years, employing two steamers with single gangs. We have caught up to date this season 3,500,000. We caught last season 7,000,000. We received the first fish this season on the 10th of May; last season, 14th of April; both caught in purse-seines. We average one gallon of oil to the thousand. We received fish on the first day of last December, on which date the factory closed. We notice mackerel among the menhaden the latter part of May, but do not see any after the 1st of July. In the bays, mackerel are not caught among the menhaden. I do not know whether fish spawn here or not. The food-fishes in this locality are sea bass, bluefish, kingfish, and weakfish, all of which are caught in pounds. The first salmon ever known in these waters was caught in a pound trap this season and weighed 20 pounds. Fish scatter in small schools in warm weather and get together in larger bodies as the weather becomes cooler. At this place we simply dry the scrap in the sun. There are two factories located 5 miles from here at Northwest. They are owned

by Mr. Henry Wells and Messrs. Preston & Raynor, the latter being known as the Sterling Works."

The next one visited was the Neamoug Oil Works, situated at Bunker City, Shelter Island, and owned by Hawkins Bros., who made the following statement, viz:

"These works have been in constant operation for eighteen years, and employ 6 steamers carrying 8 gangs. We have caught up to date 7,000,000 of fish. Last year's catch amounted to 19,000,000. We received the first fish on the 15th of May. The factory closed on the 6th of November. There were some fish here after that date. We do not know anything about mackerel. There are more menhaden this year than have been known for the past three years. Fish have gone farther east than usual this year. We think that the temperature of the water governs them altogether. This firm makes an annual report to Professor Baird at Washington."

On the same date, Captain Almy visited the Novelty Oil Works, located at Promised Land, Napeague Bay, Long Island. The proprietor, Mr. James Smith, made the following statement, viz:

"These works have been in continuous operation since 1879, employing two steamers with single gangs. We have caught up to date this season 2,700,000 fish. Caught last season 7,003,000. Received the first fish on May 16. Closed last year on the 16th of November. The present yield is two gallons of oil to the thousand."

Mr. James Smith also informed us that the factory of E. Tuthill & Co., located near here, corresponded nearly with his own in regard to the number of gangs at work and in most other respects.

Captain Almy remarks that there is one point upon which they all agree, which is the great abundance of fish. Those who have been longest in the business contend that if fish are not in this locality they are in some other; that they go where their food is most abundant in the same manner as do other fishes; and that their natural enemies destroy thousands where men with all their modern appliances catch one.

On the same date, July 11, the Excelsior Oil Works located upon Hicks Island, Promised Land, Napeague Bay, was visited. The superintendent, Mr. O. H. Bishop, made the following statement, viz:

"These works have been running four years, employing two steamers, each carrying one gang. We have caught this season up to date 2,100,000 fish. Last year's catch was 6,300,000. The first fish was caught in a purse-seine on May 19. Last year these works closed upon the 23d day of November, and we received fish up to that date, the biggest catch of the season being on that day. The yield of oil so far this season has been 1 gallon to the 1,000. I believe that some grades of these fish are spawning constantly every month that they are on this coast. Fish do not show in schools until the temperature of the water is about 54° Fahr. There are more fish here this season than have been

seen for the past four years. The principal food-fish in this locality are weak-fish, butterfish, scup, and bluefish, the latter species being very numerous this year. Menhaden have gone farther east this year than for the past four years."

There are five factories now in operation in this vicinity, which is a very central location for fishing.

On the same date the factory of the Montauk Oil Company, located at Promised Land, Napeague Bay, Long Island, was visited. The superintendent made the following statement, viz:

"We have been running for four years, employing three steamers carrying four gangs. Caught this season up to date 7,000,000 fish. Last year's catch was 13,500,000, working three gangs. The first fish this season were taken on the 18th of May. These works were closed last year on the 5th of November. The present yield is less than a gallon of oil to the 1,000. Fish are more plentiful this season than they have been for the past four years."

The next one visited was the Falcon Oil Works, located at Promised Land, Napeague Bay, Long Island, George E. Tuthill & Co., proprietors. Mr. Tuthill made the following statement, viz:

"These works have been in operation for twenty years, employing 2 steamers with four gangs and one sailing gang. We have caught up to date 6,000,600 fish in purse-seines and 5,400 in pounds. Last year's catch was 11,500,000. Our first fish this season were taken on the 29th of May. These works were closed last season on the 10th of November. At present the yield of oil to the thousand is 1½ gallons."

The next one visited was the Dixon Oil and Guano Campany's Works, in the same locality. Mr. Hiram R. Dixon, owner and operator, made the following statement, viz:

"I have been in business for four years, employing three steamers carrying four gangs. Have received this season up to date 1,509,390 fish (equal to 5,135 barrels). Last year's catch was 1,451,184 fish (equal to 4,936 barrels). The first fish this season were received at the factory on the 25th of May. This factory was closed last year on the 7th of November. The yield of oil is 2 quarts to the barrel of fish."

The next one visited was that of the Ranger Oil Company, in the same locality, Thomas T. Price, David G. Floyd, and John L. Lawrence, proprietors. The superintendent made the following statement, viz:

"These works have been in operation for fifteen years, employing three steamers carrying four seines and one sailing gang. We have caught up to date this season 5,000,000 fish. Last year's catch was 9,700,000. The first fish were received on the 12th of last May. These works were closed last year on the 17th of November. At present the average yield of oil is two gallons to the thousand. The yield of oil last season was 1,857 barrels."

The first factory visited on the morning of July 12 was that of E.

R. Kelsey, situated at Branford, Conn. He made the following statement viz:

"This factory has been in operation for fifteen years. We catch fish in pounds, and do not use purse-seines. We do not use steam like the other factories, but cook the fish by dry heat in large iron tanks set over coal fires. We fish 3 pounds, and have caught up to date this season 2,000,000 fish. Last year's catch amounted to 1,500,000. We received the first fish on May 14. We closed last year on September 20. I do not know where menhaden winter nor what they eat; have no idea what effect change of temperature of water or air has upon them. Their arrival and departure is very much affected by the temperature of the water. I cannot suggest any improvement over the present method of taking menhaden If I knew of one, I should adopt it."

The next factory visited was that of George W. Miles, located at Milford, Conn. He made the following statement, viz:

"This factory has been in operation for nineteen years. We employ at present three steamers, carrying four gangs and two sailing gangs. We have caught this season up to date 10,000,000; last years catch was 20,000,000. Received the first fish on May 15; last fish last season on November 15. The average of oil to the thousand fish is 3 gallons. We press the fish three times. The best months for fishing are July and August. The greatest amount of fish we have taken is one season was 38,000,000. We make complete fertilizers for all farm crops, and have large quantities of rock phosphate on hand. I do not know where menhaden winter nor what they eat. The temperature of 54° Fahr. is considered best for fish to show in. Their arrival and departure is affected by the temperature of the water. If we knew of any better way of taking fish we should adopt it. The purse-seine is at present the best contrivance we know of for caching all fish that come to the surface in schools."

On July 13, off Cedar Point, Connecticut, Captain Almy boarded a fishing steamer, and asking the same questions as before, received the following replies, viz:

1. Steamer Montauk.
2. Geenport, Long Island.
3. John W. Burns.
4. Yes.
5. Small menhaden.
6. 10th of May; off the coast of New Jersey.
7. Four miles per hour.
10. Three millions.
11. Three millions.
15. Length, 160 fathoms; mesh, 2¼ inches.
18. Twenty-five men; two gangs.
19. Southerly and westerly winds.

20. The whole length of Long Island.

21. I do not know where they winter.

22. They feed on brit and a kind of jelly on the surface of the water.

23. Fish in the sound do not show during a cold north wind. They do not show in the spring until the temperature of the water reaches 52° F.

25. I can suggest faster boats as the only improvement.

Answers on board the next fishing steamer at the same place:

1. William A. Wells.
2. Greenport, Long Island.
3. W. G. Bailey.
4. Yes.
5. Very small menhaden.
6. I first saw them on the south side of Long Island.

10. Eleven hundred thousand.

11. Twenty-four hundred thousand.

21. I believe that they winter on the coast of Florida.

24. I think it is.

25. Faster boats would be a great improvement. Last year, mackerel were quite numerous; this year we have seen very few. I think that if no menhaden were caught when they first appear on the coast until about the 10th of June, they would come in the bays where they spawn. I believe it would be better for all if a law were passed prohibiting menhaden fishing until the 15th of June.

Answers on board the next fishing steamer off Cedar Point, Connecticut, July 13, 1883:

1. Steamer Portland.
2. Port Jefferson.
3. M. J. Morran.
4. Yes.
5. Small menhaden.
6. The first mackerel are usually caught between Capes Hatteras and Henry, about the middle of April. We caught the first menhaden off Long Branch, N. J., on May 14.
7. Fish making a passage usually travel about two miles an hour.
8. Caught in all depths.

10. Fifteen hundred thousand.

11. Four million four hundred and five thousand seven hundred.

15. Length, 220 fathoms; mesh, $2\frac{3}{4}$ inches.

17. Very few; occasionally bluefish.

20. The whole length of the sound.

21. We think on the coast of Florida or western edge of the Gulf.

22. Do not know.

23. They scatter in warm weather and come together in cooler weather.

24. Yes.

25. I believe that steam launches could be used to set seines out.

On July 13 Captain Almy visited the factory of Luce Brothers, whose foreman made the following statement, viz:

"This factory has been in operation twenty-three years, employing three steamers, carrying four gangs. We have caught up to date this season 5,312,000 fish; caught last year 13,000,000. Received the first fish this season on May 14. Closed last year on the 16th of November. The last fish was taken on that date. The average of oil to the thousand fish is 2 gallons at present. We catch very few edible fish with menhaden. Very few fish are caught after the water is colder than 52° Fahr. We rig our seines deeper for outside fishing than for fishing in the bays. The principal edible fish in this neighborhood are tautog, flounders, small mackerel, bluefish, weakfish, and cunners. Eels are very plenty. No large mackerel ever come here. We get the most fish during calm weather. The largest catch ever known at this factory in one season was 29,000,000. Fish were much fatter last season than this. More fish have been reported on this coast this season than have been known before for three or four years."

We left port again at 3 p. m. July 16, with a number of naturalists on board, for an off-shore trip. The weather was calm and clear, with smooth sea. Several swordfish were sighted off No Man's Land, and the steam cutter lowered for one, but failed to get it.

At 9 a. m. the following day we cast the lead in 1,346 fathoms, latitude 39° 27′ 10″ N., longitude 69° 56′ 20″ W., and put the trawl over. We made another haul in 1,362 fathoms, latitude 39° 26′ 16″ N., longitude 70° 02′ 37″ W. Both hauls were successful. We also took a set of serial temperatures and water specimens from the surface to 1,000 fathoms.

The last haul was finished about 10 p. m., when the vessel was headed to the southward, and at daylight the following morning we cast the lead in 1,735 fathoms, latitude 38° 52′ 40″ N., longitude 69° 24′ 40″ W., and put the trawl over. Another haul was made during the day in 1,731 fathoms, latitude 38° 53′ N., longitude 69° 23′ 30″ W. Several new species were found both yesterday and to-day. A set of serial temperatures and water specimens was taken from the surface to 1,600 fathoms. Bottom temperatures were observed also, and a water specimen taken from 1,731 fathoms. The last haul was finished at 9 p. m., when we started for port.

The weather continued pleasant and the sea smooth. The dredging apparatus worked well, but the blocks are wearing rapidly and will require repairs. The arc light was used for night work and answered the purpose admirably, the naturalists finding no difficulty in picking over the contents of the trawl and carrying on the usual work on deck. There were two Negretti-Zambra thermometers lost during the trip and about 300 fathoms of heavy sounding wire used on the small sounding machine

for taking serial temperatures. We arrived in port at 3 p. m., and anchored in Great Harbor.

At 12.35 p. m. July 20 we left Wood's Holl for Newport, R. I., for coal, arriving at 4.30 p. m. We received on board 100 tons, and at 12.20 p. m. on the 24th left for Wood's Holl, arriving at 4.55 p. m.

At 3.15 p. m. on the 25th we left port for an off-shore dredging trip. The weather was clear and pleasant, with light southerly winds. At 2.35 p. m. the following day we got soundings in 2,033 fathoms, latitude 38° 30′ 30″ N., longitude 69° 08′ 25″ W. The wire parted while reeling in, and we lost the specimen cup, thermometer, and 92 fathoms wire. The trawl was lowered and brought up a bottom specimen, which proved to be globigerina ooze. The haul was successful although the quantity of material was quite small. There was no attempt at rapid work, two hours and eighteen minutes having been spent in veering 2,700 fathoms of dredge rope and landing the trawl on the bottom. It was hove up in one hour and fifty-five minutes.

At 5.58 the following morning we cast the lead in 2,451 fathoms, bottom globigerina ooze, latitude 37° 58′ 30″ N., longitude 69° 01′ 20″ W., and commenced taking a set of serial temperatures and water specimens, when, in slacking away the forward boom-guy, it was accidentally let go and the boom flew aft, violently striking the fore-rigging with sufficient force to break it at the heel where it entered the metal socket. The rope was hove in, the boom repaired, and at sundown we were in working order again.

Our method of taking serial temperatures and water specimens is as follows, viz: A cast-iron sinker weighing 500 pounds is shackled to the dredge rope, a few fathoms veered out, and a Sigsbee water cup and Negretti-Zambra deep-sea thermometer secured to it. The rope is then veered rapidly and the instruments secured at the desired intervals until the series is complete. The necessary time being allowed for the thermometers to take the temperature, the rope is hove in at any desired speed and the instruments taken off as they come up. The above method is generally used for 100 fathoms and upwards, the Tanner sounding machine being utilized to complete the series to the surface.

There was a brisk breeze and considerable swell during the day, but the wind moderated during the evening and the sea went down. We hung the arc (electric) light over the side after dark and kept it there about two hours. A small school of squid was attracted by it, and several small fish were seen near the ship, although it is not certain that they were attracted by the light. Several petrels were dazzled by it and fell on board, where they were captured for specimens.

At 4.33 a. m. on the 28th, we sounded in 2,976 fathoms, globigerina ooze—latitude 37° 54′ 49″ N., longitude 68° 05′ 25″ W. This depth was unexpected, and as there was some doubt as to the accuracy of the sounding, it was repeated, 2,900 fathoms of wire allowed to run out, and then an attempt made to reel in, but the sinker had not reached bottom and

was still attached. This extra weight being put upon the wire, it soon parted at 825 fathoms. We lost the specimen cup and thermometer. The result of this sounding was a surprise, and indicated the extension of the 3,000-fathom hole much to the eastward of its supposed limit. We did not intend to work in over 2,400 fathoms during the trip, and were not prepared for a depth of nearly 3,000, having but 3,400 fathoms of dredge rope on the reel.

At 11.54 a. m. we sounded in 2,369 fathoms, globigerina ooze—latitude 38° 19′ 26″ N., longitude 68° 20′ 20″ W. The wire kinked and parted at 19½ fathoms while reeling in. The specimen cup and thermometer were lost. The deep-sea trawl was put over at 1.03 p. m., and at 4.03 p. m. it was on the bottom, 3,200 fathoms of rope having been paid out. At 5.50 we commenced heaving in, and at 8.15 the trawl was up. The haul was successful, many new and interesting forms having been brought up. After the trawl was up, we took a set of serial temperatures and water specimens to 1,000 fathoms.

On July 29 there was a moderate to brisk breeze from southwest to northwest, and moderate swell; passing squalls. At 4.20 a. m. we sounded in 2,226 fathoms, globigerina ooze—latitude 38° 35′ 13″ N., longitude 68° 16′ W. At 5.57 put the deep-sea trawl over; at 8.28 trawl down, having veered 3,000 fathoms of rope. Commenced heaving in at 11.05, and at 1.38 p. m. the trawl was up. The haul was successful, although many small specimens were washed through the meshes of the net by the motion of the vessel in the lumpy sea. After the trawl was up, we steamed to the northward about sixty miles to get shoaler water.

At 3.15 a. m. on the 30th we sounded in 1,608 fathoms, globigerina ooze, and put the deep-sea trawl over—latitude 39° 22′ 50″ N., longitude 68° 25′ W. At 10.31, sounded in 1,555 fathoms, globigerina ooze, and put the deep-sea trawl over in latitude 39° 33′ N., longitude 68° 26′ 45′ W.; at 5.07 p. m. cast the lead in 1,467 fathoms, the character of the bottom the same, and put the deep-sea trawl over in latitude 39° 49′ N., longitude 68° 28′ 30″ W. The three hauls made during the day were very successful, many new and interesting specimens having been obtained.

Five hauls of the trawl were made on the 31st, in from 1,067 to 373 fathoms, between latitude 40° 00′ 30″ N., longitude 68° 37′ 20″ W., and latitude 40° 02′ N., longitude 68° 50′ 30″ W. We lost a trawl net during the day; with this exception the hauls were successful. After the last haul a set of serial temperatures and water specimens were taken to 500 fathoms.

On August 1 there was clear, pleasant weather and smooth sea. Four hauls of the trawl were taken during the day in from 1,025 to 1,106 fathoms between latitude 39° 43″ 40′ N., longitude 69° 20″ W., and latitude 39° 40′ N., longitude 69° 21′ 25″ W. During the first haul, while heaving up the trawl, the rope parted; the trawl, wings, and 2 or 3

fathoms of rope were lost. The rope parted at a kink. With the above exception the hauls were very successful. At 10.20 p. m. we started for Wood's Holl, arriving at 2.05 p. m. the following day, when the specimens were transferred to the laboratory.

At 11 a. m. on the 6th we left for Newport, where we arrived at 6 p. m. and anchored for the night. At 9 a. m. the following day we got under way and proceeded to sea for the purpose of ascertaining the present location of menhaden and other schooling fish in the waters adjacent to Block Island, Montauk, and the southern coast of Long Island. The weather was clear and calm, the glassy surface of the sea enabling us to discover the smallest ripple at any distance within the line of vision. A lookout was kept both on the bridge and at the mast-head. We stood directly for Block Island and, passing it on the starboard hand, ran 11 miles SSW. ½ W., then 9 miles NNW. 25 miles S. by W., then 26 miles N. ¼ W. which brought us inside of Montauk Point, where at 7.10 p. m. we anchored for the night. There were no schooling fish seen during the day. We were under way again at 4.30 a. m. the following day, and stood along the southern shore of Long Island from 3 to 5 miles from land until off Shinnecock light, but no fish were seen. We then turned off shore S. by E. and soon saw small schools of menhaden, and at 9 miles from land saw large schools extending about 7 miles. Reaching a point 20 miles S. by E. of Shinnecock, we changed the course to ENE. ¾ E. and ran 60 miles. After steaming about 18 miles on the above course, large schools of menhaden were seen, and we continued to pass them for nearly an hour. Schools of small mackerel, porpoises, and an occasional sword-fish were seen during the day, but no more menhaden. Having brought Block Island to bear NW. by N. 23 miles distant, we ran for it, anchoring at 6.50 p. m. off the basin.

At 5 a. m. the following day we got under way and ran 33 miles SE. by E., 25 miles E. by S., 15 miles NNE. ¾ E. to within 6 miles of the south coast of Nantucket, then 18 miles NW. by W. ½ W. and 10 miles W. to No Man's Land, which we rounded within a mile or two of the land and stood for Gay Head, where at 6 p. m. we anchored for the night. A few small schools of menhaden were seen soon after leaving Block Island. Small mackerel were encountered at intervals throughout the day, and quite a large number of sword-fish were seen also. We were under way again at 6 a. m. on the 10th, and ran SW. by W. 20 miles, then laid a course direct for Newport, where we arrived at 10.52 a. m.

I would call your attention to the statement of Captain Tuttle, in Captain Almy's report, in which he says that codfish caught winter before last between Barnegat and Fire Island were found to have menhaden in their stomachs. I would also call your attention to Mr. Nicholas Ball's statement that codfish arriving on the Block Island grounds

about the 1st of April have spawn in them, but have none when they return in October.

The following is the report of Captain Jacob Almy, fisherman expert, viz:

On Sunday, August 6, I interviewed Mr. Church and Messrs. Brown & Brightman, the only two firms doing business in Narragansett Bay. Mr. Church made the following statement: "Mackerel and menhaden make their appearance on this coast about the same time, from the 1st to the middle of May. The menhaden coming first travel much faster than those appearing afterwards. They are caught from the shore to 30 miles at sea. Our last year's catch by 8 gangs was 140,000 barrels. The average of oil to the barrel of fish was $1\frac{3}{4}$ gallons. Our entire catch this year to date is 90,000 barrels. The average yield of oil this year is $\frac{2}{3}$ of a gallon to the barrel of fish. I believe that menhaden do not spawn until the months of December and January; when leaving here they are full of spawn. I believe it would be safe to offer one dollar each for every menhaden found in the spring containing ripe spawn."

Messrs. Brown & Brightman stated as follows:

"We have caught up to date this year 39,000 barrels of menhaden with an average of $\frac{2}{3}$ of a gallon of oil to the barrel of fish. Last year's catch was 23,000 barrels with an average of $1\frac{3}{4}$ gallons of oil to the barrel.

We use seines 200 fathoms long with $2\frac{1}{4}$ to $2\frac{5}{8}$ inch mesh, which only last one year. We employ twelve men to a seine and run five gangs. I believe that the food-fishes caught with the menhaden would not be enough to supply the men taking them with fresh fish to eat. Warm southerly winds are the best for taking menhaden. I believe that very few if any of these fish spawn here. They have large spawn in them when they leave here in the fall, and have none when they return in the spring. We have no idea what they eat, but believe that they feed sometimes from the bottom and sometimes from the surface. We cannot suggest any better method of taking them."

This vessel left Newport on the morning of the 7th instant, and proceeded to sea. At 9.45 Brenton's Reef bore abeam, course SW. $\frac{1}{2}$ W. We saw between Point Judith and Block Island a fishing steamer standing to the eastward, probably making for New Bedford. At 12.30 p. m. changed course to NNW. and ran $9\frac{1}{2}$ miles, then to S. by W. and ran 24 miles, then to N. $\frac{1}{2}$ W. and at sunset anchored off Montauk Point. We saw two fishing steamers off the point. After anchoring I boarded two smacks engaged in taking sea bass.

Capt. A. H. Tuttle, of the vessel Louise, from Greenport, made the following statement:

"I have formerly been engaged in the menhaden business. They come to the coast from the 15th of April to the 10th of May. The first fish that make their appearance are usually larger than those which follow. The second run are those which stop and school in the bays and inland waters. Their food is a very small marine insect, which appears

under the microscope to be a species of crab. During the winter before last all the codfish caught from Barnegat to Fire Island were found to have menhaden in their stomachs, proving that there were menhaden on that ground all winter. They do not strike the coast at some southern point and work along northward, as some suppose, but come to it directly from the sea, although after reaching it their course is to the northward. I have noticed that very few menhaden spawn in this locality and very little ripe spawn at any time in the fish that come here. About August 1 they come out of Long Island Sound and go to sea, continuing to do so until snow falls in the autumn. Usually schools of mackerel come here about June 15, and make a short stop before going east. Menhaden, when traveling, will sometimes school and show on the surface if the weather is cold, but feeding fish do not show unless the weather is warm."

Capt. D. Racket, of the smack Georgeanna, from Greenport, engaged in taking sea bass, made the following statement:

"I have seen menhaden nearly every day in the neighborhood of Montauk Point. Hook-fishing, as a general thing, has been good this year. I consider 150 fish to each man per day a fair average."

On the 8th we got under way and stood to the westward along the southern shore of Long Island. We saw a number of small schools of menhaden off Shinnecock, the light bearing abeam about 4 miles distant. At this point changed course to S. by E., and 9 miles from Shinnecock saw large rafts of menhaden considerably strung out and in sight in all directions. We saw them first at 8.45 a. m., and passed the last at 9.30 a. m., the vessel then making 9 knots. No fishing gangs were in sight. It was nearly calm, with very light airs from the westward. Off shore of these fish we saw numerous "puffing pigs" and one swordfish. Eighteen miles on this course we saw a school of small mackerel. Tide rips here have a very peculiar appearance, and strongly resemble mackerel schooling. At 10.40 a. m., Shinnecock light being 21 miles to the northward and westward, the course was changed to ENE. $\frac{3}{4}$ E. At noon saw several schools of menhaden, and continued to see them until 1 p. m. At 3.30 saw a very large school of porpoises, Block Island bearing abeam about 15 miles distant. Anchored off the basin, Block Island, for the night. After anchoring I went on shore and interviewed Mr. Nicholas Ball, one of the oldest residents of the place, who made the following statement:

"The net profits of the fisheries of this island for the year 1882 amounted to $42,325. This money was mostly realized from the sale of salt fish and oil. Codfish arrive here about the 1st of April, and are caught until the first of June, when they disappear. They have spawn in them when they arrive in the spring, but when they return, about the middle of October, they have none. They usually remain here in the fall until the latter part of December. Mackerel arrive here about June 1; they make a very short stop, seldom longer than two

weeks. Menhaden do not make any stop here, but are frequently seen making passages. Bluefish arrive about the middle of June, and, like scup and weakfish, are a local fish at this season of the year. There are some fish in the different ponds on the island, and good oysters are obtained if the entrance to the large pond is kept open. About 350 men are engaged in the fisheries at this place."

At 5 a. m. on the 9th instant we got under way and set course SE. ½ S. We saw three small bunches of fish near the island. Twelve miles on this course we saw a school of small mackerel, and a short distance farther on another school. I am certain that they were mackerel, for some large fish were feeding upon them, causing them to jump entirely out of the water so that they could be plainly seen with a glass. At 9 a. m. changed course to E. by S. At 9.45 we saw another school of small mackerel. Swordfish were seen at short intervals during the day; I counted 16 from the deck of the ship. The dinghy was lowered and we tried for an hour to catch one, but, the conditions not being favorable, did not succeed. The weather was very mild, with light breeze from the eastward all day. At 2 p. m. we saw two schools of small mackerel 7 miles south of Nantucket Island, and at 3 o'clock, the ship running to the westward, saw another. Anchored just before sunset inside Gay Head. I visited the shore, but could not obtain any information, although the people here live principally by the occupation of fishing.

At 6 a. m., on the 10th got under way and stood SW. ⅜ S. for 20 miles, then NNW., and at 11 a. m. anchored in Newport Harbor. We did not see fish of any kind on the passage; saw one menhaden steamer bound to the southward.

We left Wood's Holl at 1.40 p. m., on the 20th instant, in search of mackerel in the regions about Nantucket, George's Bank, Cape Sable, Grand Manan, &c. After passing Gay Head and No Man's Land, a course was laid for South Shoal light-ship, but a fog came on before we reached it, narrowing our vision so much that I concluded to lay to until it lighted up. We saw no fish during the day. At 4.30. the following morning the fog cleared away and we started for George's Bank. Passing to the northward of Cultivator Shoal we then ran through the passage between it and George's. The fog came on again soon after we cleared the passage, and not wishing to pass over any ground in this vicinity without a thorough search, we stood off and on during the night under low speed, and at daylight, the following morning, resumed our course around the bank in from 30 to 40 fathoms of water; then ran across to Cashes' Ledge; thence to Brown's Bank, where we arrived on the morning of the 23d; ran over its entire length from north to south; then stood for the coast of Nova Scotia, sighting Seal Island light during the evening, and soon after crossing German Bank. The weather was squally during the night, with passing showers, but cleared in the morning. At 5.40 a. m., on the 24th, sighted Gannet Rock light at the entrance to the Bay of Fundy, crossed the Grand Manan Bank, and

stood for Mount Desert rock, where we came up with the mackerel fleet about 2 p. m. One hundred and thirty-five schooners were in sight at one time. We saw no schooling fish during the trip, and the fishing vessels spoken on George's and Brown's Banks had neither seen nor heard of any in that region during the season. They had appeared on Grand Manan for three days about a month since. The fleet were cruising between Mount Desert Rock and Jeffrey's Bank, but were meeting with poor success. Having passed the fleet, we stood for Jeffrey's Bank, Platt's Bank, Jeffrey's Ledge, and thence to Portsmouth, N. H., where we arrived at 9 a. m. on the 25th.

Capt. Jacob Almy, fisherman expert, reports as follows:

"We left Wood's Holl on August 20, and passed out of Vineyard Sound to the southward; at 3 p. m. Gay Head bore abeam. Did not see any surface fish in the sound. Passed six smacks engaged in taking bluefish. There was a fresh breeze from the southwest. At 4 p. m. No Man's Land bore abeam. As night came on and the weather became foggy, we stopped the engines and lay to until morning. At 8.30 on the morning of the 21st, the fog lifted, with moderate breeze from the southwest. Saw this morning one whale of the hump-back species, the first sign of marine life seen since leaving port. At noon saw a school of porpoises. Passed one fishing vessel at anchor and several under way, supposed to be engaged in the cod fishery. At 2.30 p. m. saw two fin-back whales. At 3 changed course and passed between Cultivator and George's Shoals. Saw a fisherman running to the eastward. Towards sunset we were enveloped in a dense fog, which cleared away about 9 p. m.

The morning of the 22d was clear and pleasant, wind from NW. We are bound to the northward along the eastern edge of George's Bank. The tide rips around these shoals are very peculiar in appearance and would generally be taken for breakers in shoal water. Saw only one school of porpoises and one swordfish during the day. Saw two fishing vessels in the afternoon, one of which, the Anna H. Mason, of Gloucester, Mass., was visited. Capt. Joseph Lyle stated as follows:

"I struck fish this morning, although I have been two days on the bank; have about 100 fish on deck. Codfish are local here, and can be caught in any month of the year. They go in schools on the bottom and never appear on the surface. They spawn here in January and do not take the hook while that season lasts. The reason, I believe, that they do not feed while spawning is that they are easily caught in nets when they will not touch a hook. The male fish are larger than the female. Consider the practice of throwing gurry overboard on fishing ground injurious. Vessels anchoring to windward and throwing overboard their offal spoil the fishing for vessels to leeward. Vessels engaged in bank fishing are generally worked with the agreement that the vessel and outfit take half, and the crew the other half of the proceeds. Eight men constitute a crew. There are no officers except the

captain. A trip usually lasts about three weeks, from four to six tons of ice being required to preserve the catch. I consider a vessel of this size to be worth about $12,000. There are many more vessels engaged in this business at present than there were six years ago. We save from all fish the livers: from cod, the sounds and tongues. We clean and dry the sounds taken from hake, which are used for a different purpose than those taken from cod. Other varieties of fish, such as haddock, cusk, halibut, pollock, &c., are taken on all parts of this bank while fishing for cod, and almost all other varieties known in our waters are plenty here at certain seasons of the year."

The morning of the 23d was clear and pleasant. At 2 p. m., while on Brown's Bank, we saw a school of porpoises and a grampus. We saw a number of fishing vessels, but none near enough to speak without going out of our course. All were under way trying the bottom for fish. At 5.56 p. m. boarded the schooner Lydia Ryder, of Pubnico, Nova Scotia, which was then taking fish. The captain made the following statement:

"We have been out 8 days and have taken 1,000 pounds of codfish, which are salted in our hold in bulk. We use for bait herring, mackerel, and squid, which are caught in nets at the port from which we sailed. I have not seen any mackerel for the last month; think that most of them are at present around the Magdalen Islands, as I have seen a number of vessels bound in that direction. Mackerel come to our place about the middle of May and leave about the last of June. Menhaden never come to our shores. We prepare our own fish, which, when ready for market, bring from four to five dollars per quintal. About the average stock for a vessel of this class for four months is $5,000. These vessels are used to carry freight during the rest of the year. We have no other officers save a captain. We fish altogether off from the vessel with hand lines. The vessel pays for one-third of the outfit, and takes one-third of the catch. The crew find their own provisions, pay the cook, furnish their own lines and hooks, two-thirds of the salt, barrels, &c., and take the other two-thirds of the fish. We found fish the first day we came on the bank. Our bait will hardly last fresh ten days on ice. There are 25 sail on the bank in this business. We catch, besides cod, haddock, halibut, cusk, and other varieties of food-fishes, besides many kinds of trash fishes."

On the morning of the 24th, I boarded the schooner T. W. L. Geser, of Westport, Nova Scotia, on Grand Manan Bank. Capt. E. M. Peters made the following statement:

"Fish are very scarce. I have been out from home fourteen days and have caught 80 quintals of codfish, which are salted in bulk in the hold. I have not seen any mackerel this trip, but last trip, four weeks ago, saw a great many, which were schooling in all directions for three days together. This vessel uses trawls, which are set from dories, of which she carries three, two men going in each. On the 20th of last June I lost one dory, with two men. They went out to set their trawl,

when a sudden fog, accompanied by a strong breeze, came up, and I saw no more of them.

"Last spring trap-fishing for mackerel at Westport, Nova Scotia, was very good. I realized $4,000 from one trap."

Leaving this vessel, we started ahead. At 9.30 saw numerous porpoises. At 1 p. m. sighted, off Mount Desert Rock, the mackerel fleet, about 150 in number. At 3 p. m. boarded the schooner Nannie E. Waterman, of Wellfleet, Mass. Capt. D. T. Pierce stated as follows:

"We have been out from home fifteen days and have caught 20 barrels of mackerel. The largest catch I have heard of, taken by any one vessel, was 185 barrels. All the mackerel I know of have been seen between Cashes' Ledge and Mount Desert. The last fish I have heard of was caught three days ago. A large majority of the vessels of the fleet have caught nothing this trip. The fish caught are small, the proportion of large ones being about a quarter.

"Mackerel first strike this coast in the spring, about the 25th of March, about 60 miles outside of Cape Henry, and arrive on Cashes' Ledge about the 25th of June. The last fish are taken in Boston Bay about the 10th of November. I never knew of any being caught in the winter. I never knew them to fail to come for the last twenty years. Schools at this season of the year are mixed, the large and small ones running together. I do not think that there is any scarcity of fish; they are always in abundance on some sections of our coast at certain seasons of the year. I do not think that anything that man can do can affects their abundance. Seven years ago they were plenty; the next year, scarce. Their food consists in part of what is known among fishermen as 'cayenne,' only seen when the water is very smooth. It then appears to skip out of the water. It is too small to be seen readily with the eye, but when taken from the stomach looks like pepper, and seems to burn the intestines after the fish is dead."

I told him what we had done for the benefit of the mackerel fleet, and described the course we had taken, its object, &c., which he promised to communicate to the rest.

Having taken on board a supply of coal and provisions, we left the navy-yard at 2.45 p. m., August 28, and proceeded to sea. The weather was pleasant, with light airs from southeast, but the wind increased during the night, and at daylight the following morning was blowing a fresh breeze from northeast.

Two hauls of the dredge were made in 105 fathoms on the northern part of George's Bank, after which we were obliged to cease work and lay to, as it was blowing a moderate gale, with heavy seas. The vessel while hove-to drifted rapidly to the westward, and at 2 a. m. on the 30th we fell in with large bodies of mackerel about 10 miles E. by S. from Cashes' Ledge. The wind moderated during the night and we steamed slowly to the eastward again. At 9.24 a. m. we cast the dredge in 99 fathoms, latitude 42° 32′ N., longitude 68° 17′ W. Four hauls of the

dredge and trawl were made during the day, notwithstanding the heavy swell and fresh winds, and in the evening a set of serial temperatures and water specimens was taken. We were working to the eastward, gradually approaching shoal water on the northern side of George's Bank, the last haul being in 35 fathoms.

We steamed slowly to the eastward during the night, and at 5 a. m. on the 31st cast the trawl in 41 fathoms, latitude 42° 05′ N., longitude 66° 46′ 15″ W. Seven hauls of the dredge and trawl were made during the day between George's and Brown's Banks in from 41 to 150 fathoms. Light to moderate winds from north to east prevailed, with moderate sea. A thick fog set in during the night, clearing away before noon of September 1. A fresh breeze sprung up later in the day, with cloudy, rainy weather. Six hauls of the dredge, tangles, grapnels, and trawl were taken, in from 65 to 131 fathoms, along the west slope of Brown's Bank, and a set of serial temperatures and water specimens was taken in the evening.

A strong wind from the eastward forced us to cease work earlier than we would otherwise have done, and, laying to with the ship's head to the southward, we drifted rapidly to the westward, reaching at midnight a depth of 55 fathoms on the east end of George's Bank. We then steamed slowly to the eastward, and, the wind having moderated, at 6.15 a. m., September 2, we cast the trawl in 858 fathoms, latitude 41° 53′ N., longitude 65° 35′ W. This haul was very successful, bringing up an enormous load of mud, small stones, and marine life. The trawl was lowered again at 11.15 a. m., and we commenced heaving up at 12.50 p. m. The wind had increased to a fresh breeze from southwest by this time, getting up an uncomfortable swell. There was another heavy load in the trawl, and, being anxious to get it on board, we took every precaution in hoisting; but the weight and rapidly increasing sea proved too much for the dredge rope, which parted at a kink 39 fathoms from the end, the trawl and that length of rope being lost. Wind and sea were now too heavy to admit of using the trawl with safety and as soon as the rope was in we steamed to the southward about 10 miles and hove to under the fore staysail, wind and sea one point abaft the beam, the Albatross's favorite position, in which she rides the seas with remarkable ease. At 6.20 p. m., latitude 41° 45′ N., longitude 65° 34′ W., saw a large school of mackerel. We were on the northern verge of the Gulf Stream, the temperature of the water being 69° F. The wind veered to west during the evening and moderated.

The weather was clear and pleasant on the morning of the 3d, clouding up during the forenoon, and at 11 a. m. a heavy rain squall passed over the ship. The wind was from the westward early in the day, backing to SW. in the squall above mentioned, veering to WSW. and NW. after noon, and increasing to a fresh breeze, with heavy swell. At 8.14 a. m. cast the small trawl in 1,309 fathoms, latitude 41° 43′ N., longitude 65° 21′ 50″ W., and veered to 1,800 fathoms of rope. The trawl

was down at 9.37; began heaving up at 10.50, and it was on board at 11.56 a. m. In addition to numerous interesting forms of marine life, we brought up about 1,000 pounds weight of stones from 6 to 10 inches in diameter. At 2 p. m., passed a ship's boat, keel up. At 4.18 p. m. the trawl was lowered in 855 fathoms, latitude 41° 40′ 30″ N., longitude 65° 35′ W. It was on the bottom at 5.10, with 1,300 fathoms of line out. Commenced heaving up at 6.02, and at 6.50 it was on deck. We then ran 5 miles WNW., and cast the lead in 810 fathoms, intending to put the trawl over, but wind and sea had increased so much that it was not considered prudent.

The two hauls taken to-day were practically in the channel between Brown's and George's Banks, although somewhat to the southward of the former. We steamed slowly to the southward and westward during the night and, at 5.13 a. m. on the 4th put the trawl over in 906 fathoms, latitude 41° 13′ N., longitude 66° 00′ 50″ W. Seven hauls were taken during the day in from 1,255 to 49 fathoms on the southeast part of George's Bank. The weather was clear and pleasant, with light northwest wind during the morning, backing to the southward in the evening. The last hauls were taken after dark, by the aid of the arc light, which was kept burning half an hour after we finished dredging for the purpose of attracting some of the numerous petrels flying about the ship, but they did not seem to mind it in the least. At 9 p. m. stood to the southward and westward, and at 5.10 a. m. cast the trawl in 959 fathoms, latitude 40° 26′ 40″ N., longitude 67° 05′ 15″ W. At 9.45 a. m. the trawl was lowered again, 10 miles south of the former position, in 1,290 fathoms, and was up at 1.27 p. m., with an enormous load of mud, and many valuable specimens.

The bottom on the north part of George's Bank was sand, gravel, and stones. In the channel between George's and Brown's Banks, stones were encountered at every haul; even to the southward of Brown's Bank, in deep water, they were brought up in the trawl. The south part of George's on which we worked, was a smooth, hard, sand bottom inside of the 100-fathom line; in deeper water we encountered a particularly tenacious mud. At the southwest extremity of Brown's Bank, on the slope outside the 30-fathom line, the bottom is covered with a variety of coral growth. We succeeded in getting several small specimens, but had no apparatus to grapple it successfully.

While heaving up the trawl last spoken of, a wreck was sighted, dismasted and water-logged, the seas making a clean breach over it. As soon as the trawl was up, we bore down upon it, lowered a boat, and sent an officer to examine it. From his report and our own observation on board it appeared to be a three-masted, square-rigged vessel of 800 to 1,000 tons, lying on its starboard side, the stern frames gone and the stern floating a few feet above water, the forward body entirely submerged. The bottom was sheathed with yellow metal, hull painted black, laden with petroleum, and to all appearances a wreck of recent occur-

rence, as there were neither grass nor barnacles on it. Its position at 2 p. m., September 5, was latitude 40° 14′ N., longitude 67° 00′ W., within the influence of the Gulf Stream, and may be expected to have an easterly drift of from 20 to 25 miles per day.

While engaged in examining the wreck, the wind was increasing rapidly from the southwest, barometer falling and heavy clouds rising from the westward, a small chopping sea following. At 2.25 p. m. we laid a course for South Shoal light-ship en route for Wood's Holl, and started ahead at full speed. The wind veered to northwest in a heavy squall before dark, and moderated during the evening, the weather clearing. At 7 a. m. on the 6th we passed the South Shoal light-ship, arriving at Wood's Holl at 1.30 p. m.

Capt. Jacob Almy, fisherman expert, reports as follows viz:

"We left Portsmouth, N. H., on August 28, and, passing the Isle of Shoals, ran to the northward of George's Bank. On the 29th the weather was stormy and rainy, the wind increasing in force to a moderate gale. At 2.30 a. m. on the 30th, saw a number of small schools and one very large school of mackerel. They did not show after daylight, though plainly visible at night. They were about 10 miles E. by S. from the shoal part of Cashes' Ledge, in about 100 fathoms of water, latitude 42° 52′ N., longitude 68° 32′ W. At 2 p. m. on the 30th saw a school of porpoises. On the morning of the 31st saw a swordfish. During the day saw several whales and 3 schools of porpoises. On September 1 saw two fin back whales. At 6.30 p. m. on the 2d, in latitude 41° 45′ N., longitude 65° 34′ W., saw quite a large school of mackerel working rapidly to windward.

"On the 5th instant, sighted a wreck and ran towards it. I went in the dinghy to examine it and found it to be a large square-rigged three-masted vessel almost submerged. The bow floated very deep, while the stern was perhaps 5 feet out of water. Could not make out her name. As we pulled to leeward of the wreck, we noticed the smell of petroleum, which led us to suppose that such was her cargo. I do not think that she had taken fire, as there were no signs of burnt wood. Her spars were gone, the foreyard hanging by the topsail sheets. She showed no signs of having been in collision. She was floating starboard side down, and had been in the water but a short time. Her length was probably 200 feet, and she was about 800 tons register. The sea was constantly breaking over her. Her position was latitude 40° 14′ N., longitude 67° 00′ W. We arrived at Wood's Holl on September 6."

We were detained several days making necessary repairs on the boilers, and on the 10th went to New Bedford for coal, returning on the 12th. We were detained by unsettled and foggy weather until 4.55 p. m. on the 19th instant, when we left with a large party of naturalists and fishermen on board to make another examination of the tilefish grounds to the southward of Martha's Vineyard. Light easterly airs,

clear weather, and smooth sea promised a favorable opportunity for our investigations the following day.

We passed through a school of small fish outside of No Man's Land, with numerous squid among them. We failed to identify the fish, but the experts on board declared that they were not mackerel. The weather was clear and pleasant the following morning, with light breeze and long swell from the eastward. At 6.55 a. m. lowered the dinghy and sent off a fishing party with trawl lines baited for tilefish. The gear was set in 70 fathoms, latitude 40° 5′ N., longitude 70° 34′ 45″ W. As soon as the boat was clear we put the trawl over, continuing to work in the vicinity, keeping the fishermen in sight until they returned at 11.35 a. m., reporting a remarkable absence of fish of all kinds, but two hake and one whiting having been taken on the 950 baited hooks. At 2.45 p. m. the trawl line was set again in 111 fathoms, latitude 40° 01′ 50″ N., longitude 70° 39′ 20″ W., with the same number of hooks baited, and was taken up at 6.45; a few hake, skate, and whiting were taken, but no tilefish. Six hauls of the trawl were made during the day in from 65 to 168 fathoms, the forms taken corresponding very closely with those taken in this locality in previous years. The morning of the 21st was clear and pleasant, with light breeze from northeast, increasing during the day to a fresh breeze and moderate sea. At 6 a. m. sent a fishing party away with trawl lines and 950 baited hooks, which were set in 117 fathoms, latitude 40° 01′ 50″ N., longitude 70° 59′ W. The beam trawl was put over and work continued within sight of the boat till 10.30, when the party returned, having taken a swordfish, several skate, hake, and whiting, but no tilefish. Our supply of bait being exhausted, we stood to the southward into deeper water for dredging, and at 1.40 p. m. put the trawl over in 1,000 fathoms, latitude 39° 42′ 50″ N., longitude 71° 4′ W. After dragging it the usual time, we commenced heaving up, but soon discerned that it had gone into the soft mud so deeply as to anchor the ship; the greatest care was observed in heaving, and finally the trawl cleared the bottom and was hove up, but there was nothing in the net, the lashing having given way and let the contents out. One of the trawl-wing bags was full of mud and some small specimens, and the trawl beam was bent so that the runners nearly met. The dredge rope was stranded also about 40 fathoms from the end. A new trawl was rigged, the rope repaired, and at 6.23. p. m. it was put over in 1,022 fathoms, latitude 39° 44′ 30″ N., longitude 71° 04′ W., and at 7.28 it was down with 1,350 fathoms out on the dredge rope. The engines were stopped and the vessel allowed to drift with the wind and sea, which gave us all the speed required. At 8.13 began heaving up, and at 9.22 the trawl was safely landed on board, with a large and interesting collection of specimens. The wind was blowing a fresh breeze by this time, with a dangerous sea for dredging; in fact, the safe landing of the trawl was due to the man in charge of the hoisting engine, who

adapted its speed to the motions of the vessel so skillfully that the danger from the heavy swell was reduced to the minimum.

Serial temperatures and water specimens were taken both yesterday and to-day. A reference to the table will show that we encountered the intervening strata of warm and cold water so marked in this region, and which, in former years, caused us to distrust our instruments on many occasions. The meager results from surface towing and from the trawl wings was remarked by the naturalists. The last haul was taken after dark by aid of the electric light, which enabled us to work with practically the same facility as in broad daylight. At 9.40 p. m. started for Wood's Holl, arriving at meridian on the 22d.

Boiler-makers were at work until the 19th of September, when at 4.10 p. m. we left port for an off-shore dredging trip. At 9.02 a. m. the following day we sounded in 1,342 fathoms, globigerina ooze, latitude 39° 29′ N., longitude 70° 58′ 40″ W., and at 9.38 put over the beam trawl, veering to 1,900 fathoms of rope. It was up again at 1.03 p. m., the net containing a large number of specimens. It was cast again at 2.44 p. m. in 1,451 fathoms, latitude 39° 22′ 20″ N., longitude 70° 52′ 20″ W. The bottom specimen brought up in the Sigsbee cup was the same as that of the former cast, but the trawl contained a granite stone weighing 170 pounds, several small stones, small pieces of cinder, and lumps of hard clay; there were also several small specimens of what appeared to be oxidized iron. The haul was very successful, being particularly rich in foraminifera. As soon as the trawl was up, a set of serial temperatures and specific gravities was taken to 1,000 fathoms. A temperature of 66° Fahr. was found at 25 fathoms, 65½° Fahr. at 60 fathoms, and 57½° Fahr. at 40 fathoms. These strata of cold and warm water are the rule rather than the exception in this locality, but thinking that possibly the observation at 40 fathoms had been read incorrectly, it was verified, using another instrument which registered 55½° Fahr. At 8.22 p. m. we started ahead S. ⅞ W. (magnetic), running on that course till 5.30 a. m., October 1, when we sounded in 1,917 fathoms, latitude 37° 56′ 20″ N., longitude 70° 57′ 30″ W., bottom globigerina ooze, and at 6.18 put the beam trawl over, veering to 2,600 fathoms. It was on the bottom at 8.04, and at 9.04 we began heaving in, landing it on the deck at 10.42 a. m., having made a successful haul. While the trawl was down we picked up a piece of drift board painted on one side and whitewashed on the other, a 3-inch pine plank, and a piece of pine timber 10 inches square and about 30 feet in length. They had been in the water from four to six weeks.

At 2.08 p. m. the beam trawl was lowered again, in 2,221 fathoms, latitude 37° 40′ 30″ N., longitude 70° 37′ 30″ W. It was down with 3,000 fathoms of rope out at 4.03 p. m., dragging till 5.14 p. m., and was landed after a successful haul at 7.24 p. m. Light to moderate winds prevailed, beginning at SSW., and veering round the compass during the day. At 7.34 p. m. started ahead SSE. (magnetic), ran till 3.26 a.

m., and lay to until daylight, about 5.30 a. m., when we sounded in 2,949 fathoms, globigerina ooze, latitude 37° 12′ 20″ N., longitude 69° 39′ W., near the center of the Gulf Stream. The sinker, 64 pounds weight, was thirty-four minutes in reaching the bottom, and the specimen cup came up in thirty-six minutes. The thermometer registered at some intermediate depth not far from the surface, having capsized in some way in its descent. The net of the beam trawl was examined with great care, and every foreign substance removed, so that there should be no doubt as to whether specimens found were taken during the haul, or were in the net when it went down.

At 7.14 a. m. the trawl was put over, reaching the bottom at 10^h 13^m 30^s, having veered 4,100 fathoms of rope. At 12.54 p. m. began heaving up, and at 3.18 p. m. it was landed on deck. It was a successful haul in every respect. The moderate breeze of the morning increased to a strong wind with heavy swell before the trawl was up, making it doubtful whether we would succeed in landing it. A set of serial temperatures and specific gravities were attempted after finishing the haul, but the strong current, high wind, rugged sea, and threatening weather forced us to give it up after having veered 300 fathoms of rope.

The method adopted to regulate the drift was at least original. The current of the stream was so strong that the trawl would not take the bottom, and to effect this object an officer was stationed on the forecastle with a dredging quadrant constantly observing the angle of the dredge rope, the engines being moved with sufficient speed to maintain it within certain prescribed limits.

At 4.30 p. m. there was a moderate gale from SW. Hove to under fore storm stay-sail, head to the southward, drifting rapidly with the stream about NE. by E. At midnight it was still blowing a moderate gale, with heavy sea, barometer 29.76, the air exceedingly sultry, and incessant flashes of lightning in every direction. At 1.40 a. m., 3d instant, we started ahead N. and ran under moderate speed till 11.05 a. m., when, wind and sea having moderated, we sounded in 1,628 fathoms, globigerina ooze, latitude 39° 22′ N., longitude 68° 34′ 30″ W., and at 12.13 p. m. put the beam trawl over, veering to 2,300 fathoms. There was still a fresh breeze from NW., with heavy swell and very strong stream. The trawl was down at 1.59, dragged till 3.08, and was landed at 4.25 p. m. There were some interesting specimens, but most of the things were washed out of the net on the way up. At 4.31 p. m. we sounded in 1,686 fathoms, globigerina ooze, latitude 39° 18′ 30″ N., longitude 68° 24′ W., and at 5.15 p. m. put the trawl over, veering to 2,650 fathoms. It was on the bottom at 7.10, began heaving up at 8.15, and landed it on deck at 9.39 p. m. The heavy swell and strong stream combined washed a large proportion of the specimens from the net, but several new or rare species were secured. A course was laid to the northward as soon as the haul was finished and the speed regulated so as to strike the 100-fathom line in longitude 67° 50′ W. at daylight, where

we proposed setting a trawl line for tilefish. We were on the ground at the proper time, but the weather was so boistrous that it was not considered prudent to lower a boat; it was too rough even for dredging, and as our coal supply was nearly exhausted, we started for Wood's Holl. We encountered strong head winds during the day, finally anchoring in Tarpaulin Cove at 10.40 p. m., where we remained till 6 a. m. on the 5th, when we got under way and arrived at Wood's Holl at 6.40 a. m., making fast to our moorings.

We remained in port till the morning of October 11, when we left for Newport, R. I., for coal, arriving at the latter place during the afternoon. Capt. Jacob Almy, expert fishermen, left the ship on the 12th, his term of service having expired. It may not be out of place for me to mention here that he has been of great service to us in his specialty. At 2.45 p. m. we commenced coaling from a schooner alongside and finished during the afternoon of the following day, having taken on board 98½ tons.

The weather, which had been unsettled with fog and rain since the 9th, cleared on the 15th, and at 5.30 p. m. the following day we got under way and proceeded to sea. We had on board, in addition to the ship's company, Capt. J. W. Collins, expert fisherman, and Mr. Sanderson Smith and Ensign W. S. Safford, naturalists.

After passing out of the harbor we stood toward Block Island, and, leaving it on the starboard hand, ran 10 miles to seaward, then changed the course to pass 10 miles south of No Man's Land, thence to South Shoal light-ship, the primary object of the cruise being a search for mackerel, menhaden, &c. With a view of gaining some knowledge of their migrations, we took the direction in which they would be most likely to appear if there were any schools on the Block Island ground. We saw none, however, and after passing the light-ship, stood for the Fishing Rip, where the schools east of Cape Cod usually disappear when leaving the coast. We saw no signs of fish on the surface, and, the water being too rough for boat work, we laid a course for Cape Cod, anchoring in Provincetown Harbor at 10.55 p. m., where we found the mackerel fleet nearly 300 in number. They got under way at daylight the following morning, the majority standing for Barnstable Bay, some going outside of Cape Cod, and others in the direction of Stellwagen Bank. Captain Collins visited several vessels during the morning to ascertain as far as practicable the movements of the schools of mackerel on the New England coast. The captains all stated that but few fish had been taken for five days, owing to unfavorable weather, and it was difficult to say where the fish were now. At 11.55 a. m. we left Provincetown, observing the fleet in Barnstable Bay as we passed out, and later those off Cape Cod, but there were no boats out. Having run about 10 miles to the eastward of Race Point, we steamed across Boston Bay and at 6.10 p. m. anchored outside of Ten Pound Island, Gloucester Harbor. The day ended with fresh southerly winds and unsettled weather. We ob-

tained but little information here, unfavorable weather having practically put a stop to mackerel fishing for nearly a week. Fresh southerly winds held during the 19th, followed by fog and drizzling rain on the 20th, ending with strong northeast winds, which continued through the 21st. The morning of the 22d opened with a moderate northeast wind and clear weather. At 6.50 a. m. we left Gloucester Harbor and steamed to the southward, passing to the eastward of Stellwagen Bank about 15 miles to seaward of Cape Cod, thence to South Channel, taking the course usually followed by mackerel when leaving the coast. No fish were seen, however, till about 10.30 p. m., when, in the vicinity of Fishing Rip, small bunches of tinker mackerel were observed from time to time under the bow. There were no large fish among them. It was our intention to use lines, gill-nets, &c., in this locality, but unfavorable weather made it impracticable to lower a boat or carry on operations of any kind with a probability of success. Having cleared the channel we stood for the South Shoal light-ship, passing it at 3 a. m., No Man's Land at 8.50 a. m., and, at 12.30 p. m., latitude 41° 07′ 30″ N., longitude 71° 07′ W., in 18 fathoms of water, on Cox Ledge, we lowered the dinghy and set a trawl-line with 500 hooks. While the boat was absent several hand lines were used by the crew; 13 codfish, 11 dogfish, and 1 hake were, taken. At 3.12 p. m. the dinghy returned to the ship, having taken on the trawl-line 21 codfish, 50 dogfish, 30 skate, 2 sea bass, 1 goosefish, 1 hake, 2 lobsters, &c. The majority of the codfish were females with partially developed roes; there were many dogfish also with half-grown young. All the fish taken were carefully examined for parasites. During the afternoon there were unmistakable signs of a northeaster approaching, and as our coal was getting low I considered it advisable to make a port as soon as practicable. With this object in view we started for Sandy Hook, under steam and sail, as soon as the dinghy was hoisted, thinking we might possibly get in before the storm reached us; but at 8 p. m. it was blowing a moderate gale with thick, misty weather. The wind and sea were increasing rapidly, and as it was not desirable under the circumstances to reach Sandy Hook before daylight, all sail was taken in and the engines slowed down. We ran before wind and sea till 4.45 a. m. on the 24th, when we hove to head to wind about 15 miles east of the light-ship, the weather being very thick. At 6.35 a. m. we started ahead under low speed, and at 11.10 a. m. anchored inside of Sandy Hook.

The gale of last night was the heaviest this vessel ever encountered at sea, and consequently her behavior was observed with great care. The rolling motion was, as usual, remarkably, easy but the pitching rather greater than it should be; the engines worked well. Sprays were flying over the rail fore and aft, but we shipped no heavy seas, and the vessel sustained no damage whatever.

At 7.30 a. m. on the 25th we got under way and steamed to the navy-yard, arriving at 11.30 a. m. Preparations were made for coaling, and

at 2.30 p. m. the next day, Friday, we commenced taking it on board from a barge alongside and finished on Monday, having received 98 tons. We received paymaster's stores on Wednesday, October 31, and at 1.10 p. m., November 4, left the navy-yard and proceeded on our cruise. The weather was hazy with light westerly winds and smooth sea.

Having passed Sandy Hook, we steamed SSE., keeping a lookout for schooling fish, and at 6.53 a. m., the following day, sounded in 1,209 fathoms, globigerina ooze, latitude 38° 44′ N., longitude 72° 38′ W. At 7.24 put over the beam trawl, landing it on the bottom at 8.43, with 1,800 fathoms of rope out. It dragged till 9.45 and was up at 10.54 a. m. At 11.14 a. m. we sounded again in 1,091 fathoms, globigerina ooze, latitude 38° 47′ 20″ N., longitude 72° 37′ W., and at 11.46 put the trawl over, veering to 1,600 fathoms on the dredge rope. It was one hour twenty-five minutes going down, dragged one hour, and came up in fifty-six minutes. Both hauls were very successful, bringing up large numbers and a great variety of specimens. At 3.41 p. m. we sounded in 991 fathoms, blue mud, latitude 38° 48′ N., longitude 72° 40′ 30″ W., and at 4.10 put the trawl over, veering to 1,500 fathoms; time going down fifty-five minutes; on the bottom one hour and sixteen minutes, and fifty-sixty minutes coming up. There were but few specimens in the net, indicating that it had been on the bottom but a short time. A modified form of wing nets, having pockets to prevent specimens from washing out, was used for the first time to-day with the trawl; and a boat dredge with light canvas bag was attached to the end of the trawl net to bring up a specimen of the bottom. After the trawl came up a set of serial temperatures and specific gravities were taken from the surface to 900 fathoms, and at 9.32 p. m. we started ahead SSW. for the night. We had light winds from W. to SSE. during the day, with clear weather and smooth sea; a perfect day for our work.

At 6.06 a. m. on the 6th we sounded in 1,395 fathoms, globigerina ooze, latitude 37° 50′ N., longitude 73° 03′ 50″ W. At 6.44 put the trawl over, and veered to 2,100 fathoms on the dredge rope; time going down, one hour thirty minutes; on the bottom, one hour thirty-one minutes; coming up, one hour seventeen minutes. It was an excellent haul; the trawl net contained a large number of interesting specimens, the wing nets caught a variety of minute forms, and the boat dredge at the tail of the trawl net came up full of foraminiferous ooze. At meridian we sounded again in 1,497 fathoms, globigerina ooze, latitude 37° 41′ 20″ N., longitude 73° 03′ 20″ W., and at 12.37 p. m. put over the trawl veering to 2,300 fathoms, the time of going down being one hour forty-seven minutes; on the bottom, one hour nineteen minutes; coming up, one hour fourteen minutes. At 5.14 p. m., latitude 37° 34′ 48″ N., longitude 73° 03′ 15″ W., we sounded in 1,542 fathoms, globigerina ooze, and took a set of serial temperatures and specific gravities from the surface to 900 fathoms; the thermometer at 1,000 fathoms failed to register. At 8 p. m. started ahead WSW. with the intention of reach-

ing a depth of 100 fathoms at daylight and setting a trawl line for tile-fish. The weather was clear and pleasant through the day with light southerly and westerly winds and smooth sea, but during the evening it clouded up and the wind increased to a strong breeze from WSW. with passing showers.

At 6.05 a. m. on the 7th we sounded in 197 fathoms, sand and shells, near the spot where we intended setting the trawl line, but the wind and sea were so high that it was impracticable to lower a boat or, in fact, to put a dredge or trawl over in safety. The day following our departure from New York, William Hall, landsman, engineers' force, was taken seriously ill with pneumonia complicated by an attack of pleurisy. He was in a critical condition, totally unable to survive a protracted gale which we were liable to encounter at any time in the region of Cape Hatteras during the month of November. Therefore I determined to transfer him to the United States naval hospital at Norfolk, Va., as soon as possible, and at 6.43 a. m. started ahead at full speed for that place. It was blowing a moderate gale from NW. with heavy sea during the forenoon, moderating later in the day as we approached land, and at 4.45 p. m., when we anchored off Fortress Monroe, it had fallen to light westerly airs. At 6.38 on the morning of the 8th we got under way for Norfolk, arriving at 8 a. m.; transfered the patient to the hospital, and at 11.45 a. m., left the navy-yard and proceeded to sea. The winds were variable during the day from light to moderate with pleasant weather and smooth sea. We passed Cape Henry at 3.17 p. m. and steamed to the southward, passing within range of the lights along the coast, keeping the usual lookout both on deck and at the mast-head for schools of fish. At 6.50 a. m. on the 9th we sounded in 19 fathoms, 19 miles NE. by E. (magnetic) of Hatteras light and put over all available hand lines baited with menhaden. The results of half an hour's fishing was one shark, and, after changing ground to 16 fathoms, 15 miles E. by N. of Hatteras light, another one was caught about 4 feet in length. Its stomach was found to contain squid enough to fill an ordinary deck bucket. Having satisfied ourselves that there were no fish to be taken here, we put over the trawl, which demonstrated the absence of life on the bottom, 1 star-fish and 3 small crabs representing the marine life found in the net. Four more hauls of the trawl with boat-dredge attached were made during the day in from 48 to 938 fathoms with excellent results. The last haul was finished at 11 p. m., with a moderate southwest gale and heavy sea, which sprung up rapidly from a fresh breeze and moderate swell during the afternoon. As soon as the trawl was landed, we steamed inshore to make a lee under Cape Hatteras, and at 2.40 a. m. the following day hove to in 15 fathoms, the light bearing SW. by S., where we found comparatively smooth water. Three hauls of the trawl with dredge attached were made in shoal water during the day, wind and sea being too heavy to admit of working in deep water off shore.

The wind moderated during the night, and on the morning of the 11th

we steamed to the eastward about 30 miles, sounding at 7.54 a. m. in 843 fathoms, mud and fine sand, latitude 35° 49′ 30″ N., longitude 74° 34′ 45″ W., and at 8.25, put the trawl over with wing-nets and dredge attached. It came up at 11.30 a. m. containing a large number and great variety of specimens, many of them exceedingly rare. Several pieces of resin came up in this haul. Various theories were advanced to account for their presence, but the romance was finally destroyed by the discovery of a piece with the fragment of a barrel stave adhering to it.

Another equally successful haul was made in 888 fathoms, blue mud and fine sand, latitude 35° 45′ 23″ N., longitude 74° 31′ 25″ W. The trawl was landed on deck at 3.41 p. m. At 3.55 we sounded in 1,066 fathoms, green mud, latitude 35° 44′ 30″ N., longitude 74° 28′ 45″ W., and commenced taking serial temperatures and water specimens; but the wind and sea, which had been gradually increasing during the day, compelled us to stop at 600 fathoms. At 5.30 p. m. we started inshore to make a lee. At 11.40 p. m. made Body's Island light, and at 12.20 a. m. on the 12th hove to and drifted till 4 a. m., when, the weather having moderated, we steamed to the eastward, and at 8 a. m. sounded in 40 fathoms, sand and gravel, latitude 36° 16′ 15″ N., longitude 74° 51′ 20″ W. As many of our fishing-grounds are on bottom of this character we tried the hand-lines, but without success. It was hardly a fair test, however, as the bait was poor and the weather unfavorable. After our attempt at line-fishing, we ran to the eastward again about 5 miles, with the intention of dredging, but wind and sea increased so rapidly that we were obliged to give it up. The amount of coal remaining would admit of but one more day at sea, even if the weather were good, and, as the NW. gale just setting in might make it impracticable for us to work for some days, I considered it advisable to make a harbor as soon as possible. At 10 a. m. started for the capes of the Chesapeake. Wind and sea being ahead, we made slow progress until up with the land, when the weather moderated, and at 10.35 p. m. we made Cape Henry light. A constant and vigilant watch has been kept for fish during the cruise, but nothing has been seen, except an occasional school of porpoises. At 1.15 a. m. on the 13th we passed Cape Henry, and at 5.30 p. m. anchored off Marshall Point, Potomac River, for the night. At 6.40 a. m. the following day we got under way, and arrived at the navy-yard, Washington, D. C., at 8.07 a. m.

The details of our fishing operations will be found in the comprehensive report of Capt. J. W. Collins, fisherman expert, which he made at the close of the cruise, as follows, viz:

REPORT OF J. W. COLLINS.

WASHINGTON, D. C., *November* 17, 1883.

SIR: Acting in accordance with instructions from Prof. Spencer F. Baird, United States Commissioner of Fish and Fisheries, I left Boston at 3.35 p. m. on Saturday, October 13, and the same evening reported

on board the ship at Newport, R. I., as soon after the arrival of the train as was practicable.

The instructions referred to above stated that—

"The principal object of this cruise will be to learn what may be ascertained in regard to the rate of travel, places of occurrence, extent of distribution, and all other phenomena connected with the southward movement of the menhaden, mackerel, bluefish, &c.; and particularly to ascertain the precise region where they seem to pass away from view, which is supposed to be the deep waters off Cape Hatteras.

"The occurrence of fishing vessels and their proportional abundance in different localities should also be noted.

"If the opportunity permits to test the hand or the trawl line in determining the presence of particular kinds of fish at certain depths, I should be pleased to have this done."

In order to carry out these instructions, it was necessary that a supply of suitable bait should be obtained for the cruise; not only because it would be indispensable in case hand or trawl lines were to be used, but also because it might be found eminently serviceable for tolling up mackerel or bluefish to the surface of the water should the weather prove favorable and the fish could not be otherwise seen.

Newport being a favorable locality to secure menhaden, which were thought to be more desirable for bait than any other species of fish, it was decided to remain there until Monday, October 15, by which time it was hoped the weather would prove favorable, not only for the local fishermen to pursue their operations, but also for us to proceed to sea and make the observations alluded to above.

It should be stated here that the weather during the previous two or three days had not been good for fishing, and therefore few if any menhaden had been taken in the vicinity of Newport; but even if there had been fair catches (it being Saturday evening when I joined the ship), it would have been impracticable to get bait so late in the week, since the catch would have all been disposed of. There was, therefore, nothing to do but to wait.

The evening of the 13th was dull with a drizzly rain and wind light from the southward.

Sunday, October 14.—The wind was moderate, veering from SW. in the morning to the westward and northward, until in the evening it was WNW. Fog and rain prevailed during the morning, followed in the evening by clearing weather.

Monday, October 15.—The wind blew from NNE. and NE. a brisk breeze most of the day, with decidedly cool weather.

I went ashore in the morning and interviewed the fishermen and fish-dealers to learn what were the prospects of obtaining bait. They all agreed in stating that there was little chance with the prevailing wind and weather of any menhaden being caught either in traps or by seining gangs. Having been referred to Mr. Noah Thompson as the person

most likely to have menhaden bait at this season, I made an engagement with him to furnish us with what we wanted if it could be obtained, and he immediately ordered a boat to beat up river, and if any fish were taken by the seining gangs to bring to Newport enough for our use. Mr. Thompson thought the boat might return about 5 p. m., but she did not come at that hour, nor, indeed, did she arrive during the evening. Her non-arrival was attributed to the cold breezy weather, which, it was supposed, had prevented the fishermen from making any hauls of menhaden. It should also be mentioned that I bought 3 barrels of salt (barrels included) from Mr. Thompson, to be used for salting any fish we might be fortunate enough to take, and which might be useful for food or bait. It was also necessary to have salt to put on the nets in case that, after being set, no opportunity offered for drying them.

Tuesday, October 16.—The weather was clear and cool with a moderate breeze from NE. to NNE. During the day we succeeded in getting 1 barrel of fresh menhaden, which had been taken in fish ponds or traps and hauled to town on carts. No fish, so far as we could learn, were caught in seines.

At 5.30 p. m. we got under way, and stood out of Newport Harbor. After getting out past Brenton's Reef, we steered so as to go to the westward of No Man's Land, after which the course was changed so that the ship should pass a few miles southward of South Shoal light-ship. This took the ship over the ground where mackerel, if anywhere in this vicinity, would be most liable to occur, and also where it was not altogether improbable that menhaden might be met with. No schools of fish were seen, however, though a good lookout was kept. It may not be out ot place to remark in this connection that easterly winds are particularly unfavorable for fish to rise to the surface, and especially when such winds are accompanied with cool weather.

Wednesday, October 17.—The wind still continued easterly, varying, during the day, from east to northeast, and moderate; weather cool. At 6.35 a. m. South Shoal light-ship was abeam about 2½ miles distant. Having steamed about 10 to 12 miles on a SE. by E. ½ E. course after passing the light-ship, we then ran ENE. ½ E. (mag.) 20.1 miles, thence 44 miles N. by W. ¼ W. (mag.). At 4.10 p. m. we changed our course to NW. by N. (mag.); ran 23½ miles.

These courses took us up South Channel and to the eastward of Fishing Rip, and thence to Cape Cod, the ship passing over the ground where there was the greatest probability of meeting with schools of mackerel that might be moving off the coast in a southerly direction. Notwithstanding that a sharp lookout was kept, not the least indication of the presence of mackerel was observable. No sea-geese (*Phaleropes*), gannets, or other birds that might denote the presence of bodies of fish, were seen, neither did we observe any porpoises, whales, blackfish, or other species which prey on mackerel, while I failed to see a single "slick" on the water—a "sign" of the presence of fish which is worthy

of notice. It is true that hagdons (*Puffinus major*) were abundant, and a flock of these birds followed the ship all day, and we also saw several jaegers, and, what was more noticeable, we saw two fine specimens of great skua gull at 10 a. m., when the ship was about 30 miles E. by N. from South Shoal light-ship. As, however, the presence of these birds is no indication that schools of pelagic fishes are in the vicinity, no importance was attached to their appearance on the grounds passed over. At 10.55 p. m. we anchored in Provincetown Harbor, where, lying at anchor, many of them with mainsails set, a fleet of 300 sail or upwards of mackerel schooners was seen.

Thursday, October 18.—Began with light easterly wind and fine, clear weather. At 4 a. m. the first of the fishing schooners began to get under way and, being called, in accordance with orders, I turned out and made preparations for boarding some of the vessels. At 5 a. m. I went on board of the Ellen M. Adams, of Gloucester, and later boarded the Ada E. Terry, of the same port, and the Alice of Portland. The captains of these vessels agreed in stating that no mackerel of any consequence had been taken for the previous five days because of the prevalence of fresh easterly winds and rough sea. Therefore they were unable to give any definite information relative to the movements or present locality of the mackerel. Each one, however, had his own idea as to the whereabouts or movements of the fish, though it is no more than fair to say these were mere speculations, based on supposition, or on rumors which might be more or less incorrect. The fact is that at this season, when mackerel are generally moving with greater or less rapidity along the coast or departing from it, there is not only great difficulty in keeping run of them during bad weather (when the fishing fleet is kept in harbor nearly all the time), but it is practically impossible for the most experienced fishermen to do better than to guess where fish may be met with in greatest abundance. Thus the skipper of the Ellen M. Adams thought mackerel would be found broad off Cape Cod, 30 to 40 miles east of Race Point or Highland light; the captain of the Alice had heard that mackerel had been seen a few days previous off the coast of Maine, and believed it possible that a body of fish might still be found to the eastward of Cape Ann; while Captain Terry, of the Ada E. Terry, held the opinion that the greater part of these fish had passed to the southward, out by Cape Cod, and believed little more would be done by the fleet during the fall. He thought, however, that small quantities of mackerel would probably be taken in Barnstable Bay and vicinity until about the 10th of November, but believed that the fish would, in nearly all cases, have to be tolled up and caught with hook and line, or else surrounded with a seine after being attracted with bait alongside of the vessel. The skippers of the vessels above mentioned all held the opinion that few schools of mackerel would be seen at the surface in the daytime, and stated that they depended, at this season, chiefly on seeing fish at night when the nights were dark enough to note the presence

of schools by the phosphorescence thrown out by the movement of the mackerel through the water. At this date the moon was so large and the nights so light that there was no probability of seeing fish between sunset and sunrise; therefore few or no vessels staid out except during the day. I bought a barrel of salt herring from Captain Terry, to be used for the purpose of tolling mackerel, &c., as occasion might require.

At 6 a. m. nearly the whole fleet was under way, working out of the harbor with a light easterly air.

At 11.56 a. m. we got under way, and stood out of Provincetown harbor. After passing Wood End we were in plain sight of the fleet of mackerel catchers in Barnstable Bay. The movements of the vessels indicated plainly that no fish were being caught at that time.*

These fish were undoubtedly caught in the day after we had left the fleet. A few of the schooners were lying to, trying to toll mackerel up, but apparently without success, for they were not "manned out," and the other vessels in company were either jogging, with jibs to windward, or running out of the fleet towards Race Point, off and beyond which were several of the mackerel catchers standing out to the eastward. Feeling satisfied that nothing was being done in the bay, the ship steamed out past Race Point and 10 miles beyond it on a northeast course, an opportunity being thus afforded for noting the movements of the vessels which had stood out to the eastward.

It may be briefly stated that not the least indication of the presence of mackerel was apparent. Many of the schooners, which had first gone out to the eastward of Race Point and the highland of Cape Cod, were seen running back, some of them being 10 to 12 miles, at least, off the land; others were still heading off close hauled on a wind while a few were hove to, trying to "raise" fish, but without success.

It being deemed advisable to learn all that could be gathered concerning the whereabouts and doings of mackerel vessels in order to judge more accurately of the movements of the fish, the ship was next headed for Gloucester, where a portion of the fleet was supposed to be. We passed over Stellwagen Bank ("Middle Bank" of the fishermen) and thence to Gloucester, seeing a few mackerel seiners on our way, none of which, however, were catching fish, or, by their actions, gave evidence in any way that mackerel had been seen.

At 6.10 p. m. we anchored outside of Ten Pound Island, and I went ashore to gather what information I could relative to the catch of mackerel, &c.

The wind, which had been light during the forenoon, increased during the latter part of the day, and in the evening there was a fresh southerly breeze.

* The report of the Boston Fish Bureau for Friday, October 19, states that "on Thursday (October 18), the weather was favorable and a fair catch of mostly small fish (mackerel) was made in and near Barnstable Bay; 800 barrels arrived here fresh this morning."

Friday, October 19.—During the morning I interviewed several of the fishing skippers, and also the fitters and owners of the fishing vessels, but failed to gather any important information concerning mackerel. The fishermen here, as at Provincetown, had been prevented by the prevalence of unfavorable weather from making any satisfactory trials to catch mackerel for a week or thereabouts. Only a comparatively small fleet remained at Gloucester, the majority of the vessels having gone over to Cape Cod, the impression being somewhat general among the fishermen that the probabilities of catching mackerel were greater there than off Cape Ann.

Capt. S. J. Martin, of the U. S. Fish Commission (who is stationed at Gloucester for the purpose of obtaining full and reliable information concerning the movements of fishing vessels, catches of fish, &c., and who is probably better informed on these subjects than any one else), told me that during the past week, or thereabouts, the fleet had been kept in harbor, and consequently little or nothing was known or could be known of the movements, presence, or absence of mackerel on the coast. On Tuesday, October 16, a fleet of 315 mackerel vessels lay in Gloucester Harbor, but since that time most of them had gone over to Provincetown. So far as Captain Martin had been able to learn by constant inquiries among the fishermen arriving from the banks and elsewhere, no mackerel had been seen at the surface, either at night or day. As these fish are usually disinclined to come near enough the surface, during the prevalence of easterly winds in autumn, to be seen by day, and, as previously mentioned, the moonlight for several preceding nights made it improbable, at least, that their presence could be detected after sunset, the fact that mackerel were not reported by incoming vessels did not prove that they might not be still on some parts of the coast in considerable abundance. At the same time, the fact that no schools of mackerel had been observed for several days and nights past by the experienced crews of the numerous fishing vessels coming into port from various directions rendered it extremely improbable that we could be successful in a search for them until more favorable weather set in.

The weather to-day was especially unfavorable, the wind blowing fresh from S. to SSW. In the afternoon, a dispatch was sent to General Hazen, Chief Signal Officer, U. S. A., at Washington, to learn the probabilities for the next 60 hours. No reply was received this evening.

Saturday, October 20.—A reply was received this morning, at 9 o'clock, from General Hazen, stating that the probabilities indicated SW. to NW. winds and clearing weather.

A drizzling rain and fog during the first part of the day was followed in the evening by a smart NE. squall, which settled down to a strong steady breeze. This kept the mackerel vessels in harbor and also prevented us from going to sea, since there was no opportunity of making anything like satisfactory observations.

Sunday, October 21.—The wind blew fresh all day from NE., and there

was considerable sea running outside the harbor. Fishing and coasting vessels arriving in port came in under close-reefed sails.

Monday, October 22.—At daylight there was a moderate northeast breeze and clear weather. Got under way at 6.50 a. m. and stood out of Gloucester Harbor. After passing Eastern Point, the ship was steered on a course which took her a little northeast of Stellwagen Bank, thence down by Cape Cod, passing the Highland at a distance of about 12 to 15 miles. From this point the course took us out the south channel, over the ground where mackerel would be most likely to occur when making their fall migrations southwardly. A sharp lookout from aloft was kept throughout the entire day. I spent some time aloft myself, but not the least indication of schooling fish of any kind was observed until about 10.30 p. m., from which hour until 11.30 p. m. scattering small mackerel (tinkers) were seen darting away from the ship's bow. We did not, however, see any large body of these fish, and the presence of those observed would not necessarily indicate that schools of larger mackerel might be met with in the vicinity. Had there been less swell, it might have been advisable to have tried during the day to raise mackerel by throwing out toll bait, but the probabilities are that, even had it been practicable to make this experiment, no good result could have been obtained with the wind from the eastward. Though it is by no means impossible to "raise" mackerel during easterly winds, experience has nevertheless proved that oftentimes they will not follow bait to the surface under such conditions of weather, even where they are known to be abundant.

Tuesday, October 23.—Began with a moderate breeze about ENE. in the early morning, gradually increasing in force as the day advanced. A little before noon we tried with hand-line for cod on Cox Ledge, having got "good bottom," coarse gravel and sand, in a depth of 18 fathoms. Nothing but a dogfish was caught on the first trial. A second trial, a mile or two from where the first was made, in the same depth and on the same kind of bottom, proved more successful, a fine cod, fish having been caught on the single hand-line put out; the dinghy was dropped from the davits, and 500 hooks of a haddock trawl, baited with fresh menhaden, were set. In the mean time all the available hand-lines were baited up with fresh menhaden and put over, the ship lying broadside to the wind and making a very good drift for fishing. As was to be expected at this season, dogfish were numerous and troublesome in so far as they often succeeded in getting hold of the hooks before the cod, notwithstanding that the latter species appeared to be in tolerably fair abundance on the ground; 13 codfish, 11 dogfish, and 1 hake were taken on the hand-lines while the ship was drifting, perhaps, three-fourths of a mile.

The dinghy, having set her trawl at about 1 p. m., began hauling about an hour later; came alongside, and was hoisted up at a little after 3 p. m. Her catch was as follows, namely: 21 codfish (averaging

about 8 pounds each, the extremes being from 3 to 13 pounds); 1 hake, 2 sea bass, 1 cunner, 2 female lobsters (2 averaging 3 pounds each, 1 carrying spawn), 30 small skate, spotted and brier, 1 large spotted skate, 50 dogfish, and 1 goosefish.

It is perhaps worthy of notice that none of the codfish, most of which were females, had roes in an advanced stage of development; they were all of the kind usually known among fishermen as "shore cod"; were plump and well fed, having fat livers. Nearly all of them had a great or less number of small crabs in their stomachs; in a few were found partially digested flounders; while it was interesting to note that two of the codfish had eaten young lobsters 5 to 6 inches long, two of these being taken from one fish and one from another. This, taken in connection with the fact of having caught two full-grown lobsters on the trawl-line, a very unlikely thing to happen, would seem to indicate that this species of crustacean were present in considerable abundance, to say the least, and suggests the possibility of this being a breeding ground of more than ordinary importance for lobsters.

The majority of the dogfish taken were females, and nearly all of these were pregnant, containing from three to seven young ones.

A close examination failed to discover any parasites on the fish taken, either on the gills or outside surface of the bodies.

Speaking in general terms, I should say that the codfish taken were what are termed "ground grubbers" or "ground feeders"; that is, fish which hang about the shore grounds, and do not usually form part of a large school which moves from place to place either in pursuit of food or impelled by the instinct of reproduction.

Sunday, November 4.—Leaving New York in the afternoon, we passed out by Sandy Hook, from which we steered SSE. (mag.). The afternoon and evening were fine, with a gentle breeze varying from SW. to NW., and smooth sea. As we were steering on a course which would take the ship across the track that the mackerel might be expected to take when making their regular autumnal migration southwardly (which is usually performed at or about this date), a bright lookout was kept, and the man on watch at the bow was ordered to report if any fish were seen darting about in the water. Ordinarily the presence of fish in the water through which a vessel is passing can be very readily detected at night by the bright phosphorescent track they leave behind when darting suddenly away to escape from the approaching ship. On moonlight nights, however, it rarely happens that the movements of fish in the water can be detected, unless, indeed, they rise to the surface and their presence is discovered by the noise they make in flapping their tails, rushing, &c.

This evening the moon was rather too bright—at least for some hours—to see any fish. A school of porpoises passed by between 8 and 9 p. m., but nothing else was seen before midnight.

Monday, November 5.—At 12.05 a. m. the lookout reported seeing fish in the water, which he thought might be mackerel. I immediately went

on the forecastle. For about an hour the ship continued to run through scattering small fish, which could be plainly seen as they darted away from the bow. At this time we were between 65 and 70 miles from the "Scotland" light-ship off Sandy Hook, and consequently in the locality where we might reasonably expect to see mackerel therefore; I was much interested in watching for them. None of those fish which we saw were mackerel in my opinion. They were too small even for "spikes."*

No fish were seen after 1 a. m., the ship in the mean time continuing on her course until at a little before 7 a. m., she stopped to obtain soundings, being then about 120 miles from Sandy Hook.

The day was spent in making hauls with the beam-trawl, and the work continued into the evening. In consequence, the large electric (arc) light was hoisted on the starboard side near the fore-rigging. This light threw a bright glare on the water alongside of the ship, and in a few minutes, scattering squid were seen darting about, having been attracted to the surface by the light. They seemed little inclined to bite at a jib, but after much trying, one specimen was taken which was pronounced by the naturalists on board to be the species commonly known as the "flying squid." The locality of this capture was latitude 38° 48′ N., longitude 72° 40′ 30″ W.

At 9.32 p. m., the day's work having been finished, the ship started ahead on a SSW. course, steaming about 7 to 8 knots. At 11.05 p. m., when about 12 miles from the position given above, the lookout reported seeing small fish under the bow. I went on the forecastle at once, but failed to see anything except a large animal which came under the bow, and which was doubtless a turtle. When questioned, the lookout stated that the objects he saw were some distance off, and appeared to be small fish at the surface. Under the circumstances, conjecture as to the species would be useless.

Tuesday, November 6.—The day was spent in making hauls with beam-trawl from deep water, the weather still remaining fine, with moderate southerly to southwest winds.

After finishing the day's work, the ship was started ahead on a WSW. course, in the direction of the Chesapeake, this course crossing a piece of gravelly bottom in about 45 to 50 fathoms, where it was intended to set line trawls the next morning should the weather prove favorable.

Wednesday, November 7.—At daylight there was a fresh and increasing breeze from WNW. veering to NW.—too much wind and sea to set trawl-lines with safety. Ship continued on her course, reaching the anchorage off Fortress Monroe in the evening, having made port to land a sick man.

Thursday, November 8.—The sick man previously alluded to having been landed at Norfolk, Va., the ship got under way and proceeded to sea, passing Cape Henry a little after 3 p. m. After getting out by the

* Mackerel hatched out the previous summer, and which at this season usually attain a growth of 5 inches or thereabouts are called "*spikes*."

cape, the ship steered southwardly, running down the coast in the direction of Cape Hatteras.

Friday, November 9.—At 7 a. m., tried for fish with hand-lines, these being baited with menhaden, and having various sizes of sinkers and hooks, most of them, however, being ordinary bank and boat codfish gear. We had previously sounded in 19 fathoms, the bottom being fine yellow sand with black specks, and fine broken shells.

This kind of ground is rarely found good for bottom-feeding fish. We caught only a single sharp-nosed shark (or smooth-backed dogfish) about 2½ feet long. Our position at this time was, approximately, 20 miles NNE. ½ E. from Cape Hatteras.

At 8.23 a. m. we sounded again in 16½ fathoms, latitude 35° 20′ 30″ N., longitude 75° 15′ W.; bottom fine sand and broken shells. Put out hand lines with same result as before, the catch being 1 female sharp-nosed shark about as large as the first.

The beam trawl was put out, but the catch—1 small crevallé, 1 star-fish, a few dead shells, and 3 small crabs taken in it—showed a scarcity of such life on the bottom as might serve for food for any of the larger species of fish.

Leaving this position we ran off shore, and at 11 a. m., latitude 35° 16′ N., longitude 75° 2′ 30″ W., sounded in 48 fathoms; bottom blue mud and coarse sand. Tried for fish with 4 hand-lines, those having the heaviest leads, the others being too lightly sinkered to use in this depth of water with any breeze blowing. Nothing whatever was taken on the lines, though they were out almost three-quarters of an hour. In the mean time, a sharp-nosed shark, which had been seen near the surface, was caught on a shark line. The fish was about 4½ feet long, and its stomach contained many partially digested squid.

The beam trawl was put out at 11.40 a. m., but, with the exception of a few specimens of small crabs, brought up nothing which might serve as food for fish.

During the day, when about 3 or 4 miles to the eastward of the position last given, and when we were steaming at full speed, a school of about 25 to 30 porpoises came by the ship, stopped a few moments under the bow, and were off again.

Mr. Miller, the paymaster's yeoman, threw the grains into a small dolphin which was playing around the ship in the evening, and was successful in catching it. The locality of this capture was latitude 35° 9′ 50″ N., longitude 74° 57′ 40″ W.

Saturday, November 10.—Several sets of the beam trawl were made in shoal water, 15 to 18 fathoms, northeastwardly from Cape Hatteras, the wind blowing so fresh from the southwest during the day that it was impracticable to dredge off shore. As in previous hauls in this locality, very few forms of life were brought up in the trawl that could serve as food for fish. The result of these numerous trials in this region would seem to indicate almost an entire absence of bottom-feeding fish, for this sandy slope north of Cape Hatteras would appear to be

barren ground. This would, however, have nothing to do with the presence of surface fish, such as find their food in free swimming animals, and it is altogether probable that at certain seasons, these waters may swarm with multitudes of pelagic species making their migrations north or south. So far as known, most of the migratory fishes that pass to and fro by this coast keep close inshore, as a rule, though it is known to fishermen that the bluefish occasionally go off to a distance of 15 to 25 miles from the land, and it is reasonable to suppose that other species may also have similar habits.

In this connection it may be well to remark that one of the principal "signs" of the presence of bodies of fish passing up or down the coast is the appearance of large flocks of sea birds, generally gulls, and fishermen have learned by experience to watch for this indication, especially when engaged in bluefishing. Comparatively few birds were seen on our cruise, these being all gulls, and those which were observed failed to give any indication, by their movements, of the presence of schooling fish, though their actions were carefully watched.

At midday, and for two hours later, the ship at the time lying to, drifting, wind blowing fresh southwest, many turtles were seen, perhaps as many as 30. These showed themselves at the surface for a few minutes, or perhaps only for one or two seconds at a time. None of them seemed to be asleep, and when they rose near us they immediately went under as soon as they caught sight of the ship. Although as many as 3 or 4 were seen up at once, no opportunity offered for their capture.

Sunday, November 11.—Spent the day in dredging with beam trawl in deep water.

Monday, November 12.—A little before 8 a. m. we sounded in 40 fathoms, latitude 36° 16′ 15″ N., longitude 74° 51′ 20″ W.; bottom dark-gray sand and gravel. We put out 4 hand lines baited with menhaden and tried for fish nearly an hour, but failed to catch anything.

The results of this trial were, perhaps, not quite so conclusive as those previously made, owing to the fact that our bait by this time was in poor condition. It is barely possible that fish might have been caught with better bait. It may, however, be safe to assume that had there been present any large number of fish, the long and careful trial that was made would have resulted in the capture of a few specimens at least.

The wind, which had been blowing fresh from southwest, causing a choppy sea to get up while we were trying for fish, shortly afterward veered to NW., and increased to a moderate gale. The ship headed in for the Chesapeake, and the fishery investigations closed, for the cruise, with the trial above described.

Very respectfully,

J. W. COLLINS.

Lieut. Commander Z. L. TANNER, U. S. N.,
Commanding U. S. Fish Commission Steamer Albatross.

REPORT OF THE NATURALIST, MR. JAMES E. BENEDICT.

I have the honor to report that upon December 14, 1882, I was appointed resident naturalist of the United States Fish Commission, Steamer Albatross, and ordered to prepare a complete outfit of collecting apparatus for that vessel. I found that Capt. J. W. Collins had procured an admirable assortment of nets, comprising trammel and gill nets, and seines fully rigged for use; also a large number of fishing lines, fish-hooks, squid-jigs, &c.; in short, all the implements of use on a fishing vessel.

But much minor apparatus remained to be procured for the ship, such as sieves, fish pans, dishes, and other things necessary in the laboratory, besides alcohol jars and vials.

The full complement of alcohol-tank boxes is forty, of which ten contain four 4-gallon tanks each; sixteen two 8-gallon tanks each, and the remainder one 16-gallon tank each. All these tanks are of copper. Their aggregate capacity is about fifteen barrels. The complement of jars is about two gross of 4-pound butter jars; two gross of 2-pound butter jars; two gross of 2-quart fruit jars; two gross of 1-pint fruit; and two gross of 1-pint fruit, and from two to five gross of each of the cork-jars, from No. 1 to No. 8, inclusive.

Two or three features of the Albatross's equipment should be specially mentioned, viz:

THE MUD-BAG.

It often happens that the bottom is of such a nature that it washes through the netting of the common dredge and trawl, leaving in our hands only the larger specimens, subject to more or less injury by stones and broken shells. To prevent this we have made a tight canvas bag about 3 feet long, and have attached it to the iron frame of a boat-dredge. Thus rigged it is attached to the end of the trawl-net. Besides the larger forms of fish and invertebrates taken with the trawl alone, this contrivance secures from deep water large amounts of foraminifera otherwise lost, and many specimens of worms, crustacea, and mollusca This alone makes the mud-bag valuable, but it has the further merit of delivering mud and ooze free from slime and fish scales, even under circumstances where they are plentifully found in the trawl-net, as, for instance, when large hauls of fish, star-fish, and holothurians are made.

I estimate that, outside of the foraminifera, the number of species captured by the use of this bag is, oftentimes, from one-third to two-thirds greater than by the trawl alone.

It was found that the lower tray of the sieve, with its one-twelfth inch mesh, permitted most of the foraminifera, annelids, small crustacea, and many minute shells to escape, and, as a remedy, the canvas discharge-pipe was turned from the scuppers into a tub placed under the sieve.

Discharge from the tub is effected by means of three pipes 6 inches in length, inserted in the following order (Plate XLVIII): One ½-inch pipe, 6 inches from the bottom; one ½-inch pipe, 6 inches higher than the first named, and in the next stave; one 2-inch pipe, in the stave next to the last named, and 4 inches from the top. The 3 pipes thus afford a sufficient discharge.

Each pipe is muzzled by a linen scum-strainer about 1 foot in diameter and 3 feet long, with the free end closed, giving so large a straining surface that the flow into the tub rarely exceeds the flow out through the strainers. This device preserves an abundance of the most minute foraminifera, and assists in the separation of mud and gravel from organisms, the first largely sinking to the bottom of the tub, the second largely passing into the scum-strainers.

THE ELECTRIC LIGHT IN COLLECTING.

The Albatross was one of the first ships fitted with Edison's electric-light. Properly shaded to protect the eyes of the collector, it is attached to the end of an insulated cable. Although it is capable of being lowered to a great distance, its successful use has thus far been confined within 3 feet of the surface, there being no efficient apparatus for collecting by its aid from greater depths. It has, nevertheless, been of good service. By its use the following crustacea were taken off Montauk Point, Long Island:

Crangon vulgaris;
Cancer;
Homarus americanus;
Palæmenetes vulgaris;
Mysis americanus;
Heteromysis formosa;
Diastylis sculptus;
Idotea irrorata;
Chiridotea Tuftsii;
Ptilochirus pinguis;
Urothea sp.;
Calliopius læviusculus;
Several other Amphipods;
Early stages of various Decapods;
Early stages of various Copepods.

Many small fish were taken by the same means at the above locality. The list of crustacea was prepared by Prof. S. I. Smith.

At Wood's Holl, Massachusetts, the sexual form of *Nereis megalops* swarmed about the light.

In the Gulf stream two species of squids, viz, *Ommastrephes illecebrosus* and *Sthenotuthis Bartramii*, the latter in large numbers, were taken by the squid-gig near the light.

Harpooning or hooking sharks or dolphins in the area of illumination is not uncommon.

Mother Carey's chickens (*Thalassidroma Leachii*, and *T. Wilsoni*), when for some reason the arc light was in use, often came on board and were captured.

Surface collecting was carried on whenever the ship's speed would permit. Long bamboo poles, with fine silk bolting-cloth nets attached, were placed in each gangway in readiness for small surface objects. Surface-nets were used from one of the swinging booms, being thus rigged instead of over the stern, to avoid their loading with cinders, coffee-grounds, &c.

A shark-line was kept in readiness, and a shark occasionally captured and examined for parasites, external and internal.

Porpoises were sometimes harpooned, but the height of the bow of the Albatross renders this a difficult feat.

In all of these operations the seamen showed great willingness to assist, and they even employed a portion of their time off duty in the capture of specimens for the laboratory, many of which proved very fine. They also brought in for preservation many specimens which had fallen from the trawl to the deck unperceived by the naturalists.

During the current year nine cruises were made by the Albatross, and one hundred and sixteen hauls with the trawls and dredges. This number of hauls would seem a small year's work for a ship so well equipped for this special purpose, if the great depth (from 1,500 to 2,900 fathoms) of many of the hauls were not taken into account; also the fact that several cruises were made almost solely to find mackerel and menhaden. The dredging was nevertheless very successful. Many new forms of fish, crustacea, mollusca, echinoderms, and anthozoa have already been described by the several specialists, and many more are still in their hands for description. In addition to the new forms numerous species, formerly rare or little known, were found in such abundance that the National Museum has on hand material enough for many sets, both for educational purposes and for exchange.

REPORT OF ENSIGN R. H. MINER, U. S. N., DEPARTMENT OF FISHES.

The operations of dredging and trawling were commenced on our voyage from Wilmington, Del., to Washington, D. C., in March and continued until our return to Washington in November. They are included within the limits of latitude 35° 9′ 40″ N. and latitude 42° 32′ 00″ N., longitude 65° 21′ 50″ W. and longitude 75° 20′ W. The work for the most part was done in deeper water than had been attempted heretofore by the United States Fish Commission. The ground between these limits was investigated as thoroughly as practicable during the season, and the distribution of species thereon reasonably well determined.

We have succeeded in finding, according to Prof. Theodore Gill, no less than eighteen new species of fish-like vertebrates—one Myzont, one Selachian, and sixteen true Fishes. Trawl lines were set several times, on different dates, for the Lopholatilus, but we did not succeed in finding traces of any.

One hundred and sixteen hauls of the trawl and dredge were taken during the season, and the list of species found is as follows, viz.:

LOPHIIDÆ.

1. *Lophius piscatorius*, Linnæus.

MALTHIDÆ.

2. *Halieutæa senticosa*, Goode.

PLEURONECTIDÆ.

3. *Monolene sessilicauda*, Goode.
4. *Citharichthys arctifrons*, Goode.
5. *Pleuronectes americanus*, Walbaum.
6. *Glyptocephalus cynoglossus*, (Linn.) Gill.
7. *Paralichthys dentatus*, (Linn.) Jordan and Gilbert.
8. *Paralichthys oblongus*, (Mitch.) Jordan and Gilbert.

MACRURIDÆ.

9. *Macrurus bairdii*, Goode and Bean.
10. *Macrurus carminatus*, Goode.
11. *Macrurus asper*, Goode and Bean.
12. *Coryphænoides rupestris*, Gunnerus.
13. *Coryphænoides carapinus*, Goode and Bean.
14. *Chalinura simula*, Goode and Bean.

BROTULIDÆ.

15. *Bassozetus normalis*, Gill, new species.

GADIDÆ.

16. *Phycis chuss*, (Walb.) Gill.
17. *Phycis tenuis*, (Mitch.) DeKay.
18. *Phycis regius*, (Walb.) Jordan and Gilbert.
19. *Phycis chesteri*, Goode and Bean.
20. *Haloporphyrus viola*, Goode and Bean.
21. *Merlucius bilinearis*, (Mitch.) Gill.
22. *Onos rufus*, Gill, new species.
23. *Onos cimbrius*, (Linn.) Goode and Bean.
24. *Gadus morrhua*, Linnæus.
25. *Brosmius brosme*, (Müller) White.
26. *Pollachius carbonarius*, Gill.

LYCODIDÆ.

27. *Lycodes verrillii*, Goode and Bean.
28. *Lycodonus mirabilis*, Goode and Bean.
29. *Melanostigma gelatinosum*, Günther.

TRIGLIDÆ.

30. *Prionotus punctatus*, (Bloch) Cuv. and Val.
31. *Prionotus carolinus*, Günther.

AGONIDÆ.

32. *Peristedium miniatum*, Goode.
33. *Aspidophoroides monopterygius*, (Bloch) Storer.

COTTIDÆ.

34. *Hemitripterus americanus*, (Gmelin) Cuv. and Val.
35. *Cottus æneus*, Mitchill.
36. *Icelus uncinatus*, (Reinh.) Kroyer.
37. *Cottunculus microps*, Collett.

SCORPÆNIDÆ.

38. *Sebastes marinus*, (L.) Lütken.
39. *Sebastoplus dactylopterus*, (De la Roche) Gill.

CARANGIDÆ.

40. *Caranx pisquetus*, Cuv. and Val.

STROMATEIDÆ.

41. *Stromateus triacanthus*, Peck.

CORYPHÆNIDÆ.

42. *Coryphæna sueuri*, Cuv. and Val.

BERYCIDÆ.

43. *Plectromus suborbitalis*, Gill, new species.
44. *Stephanoberyx monæ*, Gill, new species.
45. *Caulolepis longidens*, Gill, new species.

SYNODONTIDÆ.

46. *Bathysaurus agassizii*, Goode and Bean.

ALEPOCEPHALIDÆ.

47. *Alepocephalus agassizii*, Goode and Bean.
48. *Alepocephalus productus*, Gill, new species.

HALOSAURIDÆ.

49. *Halosaurus macrochir*, Günther.
50. *Halosaurus goodei*, Gill, new species.

STOMIATIDÆ.

51. *Stomias ferox*, Reinhardt.
52. *Hyperchoristus tanneri*, Gill, new species.

STERNOPTYCHIDÆ.

53. *Sternoptyx diaphana*, Hermann.
54. *Argyropelecus hemigymnus*, Cocco.
55. *Cyclothone lusca*, Goode and Bean.

SCOPELIDÆ.

56. *Scopelus mülleri*, (Gmelin) Collett.

SYNAPHOBRANCHIDÆ.

57. *Synaphobranchus pinnatus*, (Gronow) Günther.
58. *Histiobranchus infernalis*, Gill, new species.

NEMICHTHYIDÆ.

59. *Nemichthys scolopaceus*, Richardson.
60. *Serrivomer beanii*, Gill, new species.
61. *Spinivomer goodei*, Gill, new species.
62. *Labichthys carinatus*, Gill, new species.
63. *Labichthys elongatus*, Gill, new species.

NOTACANTHIDÆ.

64. *Notacanthus analis*, Gill, new species.
65. *Notacanthus phasganorus*, Goode.

XIPHIIDÆ.

66. *Xiphias gladius*, Linnæus.

CHAULIODONTIDÆ.

67. *Chauliodus sloani*, Bloch and Schneider.
68. *Sigmops stigmaticus*, Gill, new species.

LEPTOCEPHALIDÆ.

69. *Leptocephalus* sp. (larvæ of *Synaphobranchus*).

ANGUILLIIDÆ.

70. *Conger oceanicus*, Gill.
71. *Simenchelys parasiticus*, Gill.

EURYPHARYNGIDÆ.

72. *Gastrostomus bairdii*, Gill and Ryder.

PETROMYZONTIDÆ.

73. *Petromyzon (Bathymyzon) bairdii*, Gill.
74. *Petromyzon marinus*, Linnæus.

MYXINIDÆ.

75. *Myxine glutinosa*, Linnæus.

CHIMÆRIDÆ.

76. *Chimæra abbreviata*, Gill, new species.

RAIIDÆ.

77. *Raia eglanteria*, Lacépède.
78. *Raia radiata*, Donovan.
79. *Raia ocellata*, Mitchill.
80. *Raia lævis*, Mitchill.

SPINACIDÆ.

81. *Squalus acanthias*, Linnæus.

GALEORHINIDÆ.

82. *Scoliodon terræ-novæ*, (Richardson) Gill.

SCYLLIIDÆ.

83. *Scyllium retiferum*, Garman.

LOPHIIDÆ.

1. **Lophius piscatorius**, Linnæus.

Lophius piscatorius, Linn., Syst. Nat.; Günther, iii, 179.
Lophius americanus, Cuv. and Val., xii, 380.

The stomach of each individual was examined, and generally contained *Phycis chuss* and *chesteri*. Specimens were found at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	19
2021	37 36 00	74 15 00	179
2057	42 01 00	68 00 30	86
2092	39 58 35	71 00 30	197
	41 07 30	71 07 00	*18

* Cox's Ledge.

MALTHIDÆ.

2. **Halieutæa senticosa**, Goode.

Halieutæa senticosa, Goode, Proc. U. S. Nat. Mus., 1880, 467.

This species was collected at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2014	36 41 05	74 38 55	373
2025	40 02 00	70 27 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 32 00	209
2092	39 58 35	71 00 30	197

PLEURONECTIDÆ.

3. **Monolene sessilicauda**, Goode.

Monolene sessilicauda, Goode, Proc. U. S. National Museum, iii, 1880, pp. 338, 472 (November 23).

This species was collected at the three following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2067	42 15 25	65 48 40	122
2086	40 05 05	70 35 00	69
2092	39 58 35	71 00 30	197

4. **Citharichthys arctifrons**, Goode.

Citharichthys arctifrons, Goode, op. cit., pp. 341, 472 (November 23).

This species was obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2004	37 19 05	74 26 06	102
2014	36 41 05	74 38 55	373
2021	37 36 00	74 15 00	199
2032	39 29 00	72 19 40	74
2086	40 05 05	70 35 00	69
2087	40 06 50	70 34 15	65
2089	39 58 50	70 39 40	168

5. **Pleuronectes americanus**, Walbaum.

Pleuronectes americanus, Walbaum, Artedi, Pisc., 1792, 113; Günther, iv, 443.
Platessa plana, Storer, Fish. Mass., 373.

Specimens were found at the following stations:

Station.	North latitude.	West longitude.	Depth.
	° ′ ″	° ′ ″	
2020	37 37 50	74 15 30	143
2025	40 02 00	70 27 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 42 00	209
2053	40 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2061	42 10 00	66 47 45	115
2080	41 13 00	66 21 50	55
2081	41 10 20	66 30 20	50

6. **Glyptocephalus cynoglossus**, (Linn.) Gill.

Pleuronectes cynoglossus, Linnæus, Syst. Nat., ed. x, i, 1758, p. 269.
Glyptocephalus cynoglossus, Gill, Proc. Acad. Nat. Sci. Phila., 1873, p. 161; Goode and Bean, Proc. U. S. Nat. Mus., i, 1878, p. 21 (with extensive synonymy); Goode, op. cit., p. 475.

Specimens were obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2004	37 19 05	74 26 06	98
2014	36 41 05	74 38 55	373
2018	37 12 22	74 20 04	788
2021	37 36 00	74 15 00	179
2030	39 29 45	71 43 00	588
2078	41 11 30	66 12 20	499
2086	40 05 05	70 35 00	69
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197
2115	35 49 30	74 34 45	843

7. **Paralichthys dentatus**, (Linn.) Jordan & Gilbert.

Paralichthys dentatus, J. & G., Bulletin U. S. Nat. Mus., No. 16, p. 822.
Pleuronectus dentatus, L., Syst. Nat., i, 458.
Platessa ocellaris, DeKay, N. Y. Fauna, Fish., 1842.
Pseudorhombus dentatus and *P. ocellaris*, Günther, iv, 425–430.
Chænopsetta ocellaris, Gill., Proc. Acad. Nat. Sci. Phil., 1864, 218.
Pleuronectes melanogaster, Mitchill, Trans. Lit. and Phil. Soc. N. Y. (doubled example).
Platessa oblonga, DeKay, N. Y. Fauna, Fish, 1842, 299, pl. 48, f. 156; not *Pleuronectus oblongus*, Mitch.
Pseudorhombus oblongus, Günther, iv, 426.
Pseudorhombus dentatus, Goode & Bean, Proc. U. S. Nat. Mus., 1879, 123.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2079	41 13 00	66 19 50	75

8. **Paralichthys oblongus**, (Mitch.) Jordan & Gilbert.

Pleuronectes oblongus, Mitchill, Trans. Lit. and Phil. Soc., i, 391, 1815.
Platessa quadrocellata, Storer, Proc. Bost. Soc. Nat. Hist., 1847, 242, and in Hist. Fish. Mass., 397, pl. xxxi, f. 3.

This species was collected at the following stations, viz:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2025	40 02 00	70 27 00	239
2031	39 29 00	72 20 00	74
2087	40 06 50	70 34 15	65
2088	39 59 15	70 36 30	143

MACRURIDÆ.

9. **Macrurus bairdii**, Goode and Bean.

Macrurus bairdii, Goode & Bean, Amer. Jour. Sci. and Arts, xiv, 1877, pp. 471–473 (Massachusetts Bay); Cat. Fish Essex Co. and Mass. Bay, 1879, p. 7; Goode, Proc. U. S. Nat. Mus., iii, 1880, p. 475.

Numerous specimens were obtained from the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2002	37 20 42	74 17 36	641
2003	37 16 30	74 20 36	641
2014	36 41 05	74 38 55	373
2025	40 02 00	70 27 00	239
2028	39 57 50	70 42 00	209
2030	39 29 45	71 43 00	588
2036	38 52 40	69 24 40	1,735
2037	38 53 00	69 23 30	1,731
2039	38 19 26	68 20 20	2,369
2041	39 22 50	68 25 00	1,608
2053	42 02 00	68 27 00	105
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2063	42 23 00	66 23 00	141
2064	42 25 40	66 08 35	122
2074	41 43 00	65 21 50	1,309
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2084	40 16 50	67 05 15	1,290
2092	39 58 35	71 00 30	197

10. **Macrurus carminatus**, Goode.

Macrurus carminatus, Goode, Proc. U. S. Nat. Mus., iii, 1880, pp. 346, 475 (Nov. 23).

Specimens were obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2014	36 41 05	74 38 55	373
2020	37 37 50	74 15 30	143
2072	41 53 00	65 35 00	858
2089	39 58 50	70 39 40	168
2092	39 58 35	71 00 30	197

11. Macrurus asper, Goode & Bean.

Macrurus asper, Goode & Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5, xix; Report on the Fish, p. 196.

Specimens of this rare species were obtained at the following stations:

Station.	North latitude.			West longitude.			Fathoms.
	°	′	″	°	′	″	
2001	37	46	30	74	00	00	499½
2072	41	53	00	65	35	00	858
2074	41	43	00	65	21	50	1,309
2095	39	29	00	70	58	40	1,342
2096	39	22	20	70	52	20	1,451
2097	37	56	20	70	57	30	1,917
2098	37	40	30	70	37	30	2,221
2102	38	44	00	72	38	00	2,102
2103	38	47	20	72	37	00	1,091
2105	37	50	00	73	03	50	1,395
2106	37	41	20	73	03	20	1,497

12. Coryphænoides rupestris, Gunnerus.

Coryphænoides rupestris, Gunnerus, Thjemske, Selsk. Skr. 3, 1765, p. 50; Collett, Norges Fiske, p. 131.

Specimens were taken at the following stations:

Station.	North latitude.			West longitude.			Fathoms.
	°	′	″	°	′	″	
2003	37	16	30	74	20	36	641
2004	37	19	05	74	26	06	98
2035	39	26	16	70	02	37	1,362
3037	38	53	00	69	23	30	1,731
2041	39	22	50	68	25	00	1,608
2042	39	33	00	68	26	45	1,555
2051	39	41	00	69	20	20	1,106
2052	39	40	05	69	21	25	1,098

13. Coryphænoides carapinus, Goode and Bean.

Coryphænoides carapinus, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5, xix; Report on the Fish.

Specimens were obtained at the following stations:

Station.	North latitude.			West longitude.			Fathoms.
	°	′	″	°	′	″	
2095	39	29	00	70	58	40	1,342
2096	39	22	20	70	52	20	1,451

14. Chalinura simula, Goode and Bean.

Chalinura simula, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5, xix; Report on the Fish., p. 199.

Specimens were obtained at the following stations:

Station.	North latitude.			West longitude.			Fathoms.
	°	′	″	°	′	″	
2037	38	53	00	69	23	30	1,731
2038	38	30	30	69	08	25	2,033
2043	39	49	00	68	28	30	1,467
2077	41	09	40	66	02	20	1,255
2084	40	16	50	67	05	15	1,290
2102	38	44	00	72	38	00	1,209
2103	38	47	20	72	37	00	1,091
2105	37	50	00	73	03	50	1,395
2116	35	45	23	74	31	25	888

BROTULIDÆ.

15. Bassozetus normalis, Gill, new species.

Bassozetus normalis, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 259.

One specimen was obtained at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2042	39 33 00	68 26 45	1,555

GADIDÆ.

16. Phycis chuss, (Walb.) Gill.

Blennius chuss, Walbaum, Artedi, 1792, p. 186.
Phycis chuss, Gill, Proc. Acad. Nat. Sci. Phila., 1862, p. 237.

This species occurred at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2003	37 16 30	74 20 36	641
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	373
2021	37 36 00	74 15 00	179
....	40 05 25	70 28 00	90
2025	40 02 00	70 27 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 42 00	209
2052	42 02 00	68 27 00	105
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2063	42 23 00	66 23 00	141
2078	41 11 30	66 12 20	499
2086	40 05 05	70 35 00	69
2087	40 06 50	70 34 15	65
2088	39 59 15	70 36 30	143
2089	39 58 50	70 39 40	168
2091	40 01 50	70 59 00	117
Cox ledge	41 07 30	71 07 00	18
2109	35 14 20	74 59 10	142

17. Phycis tenuis, (Mitch.) De Kay.

Gadus tenuis, Mitchill, Trans. Lit. and Phil Soc. N. Y., 1814, p. 372.
Phycis tenuis, De Kay, Zoöl. New York, Fishes, 1842, p. 293.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2021	37 36 00	74 15 00	179
2031	39 29 00	72 19 55	74
2053	40 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2085	40 05 00	70 34 45	70
2058	41 57 30	67 58 00	35
....	40 01 50	70 39 20	111
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197
2109	35 14 20	74 59 10	142

18. Phycis regius, (Walb.) Jordan & Gilbert.

Blennius regius, Walb., Art., Pisc., 1792, 186.
Phycis punctatus, De Kay, N. Y. Fauna, Fish., 292.
Enchelyopus regalis, Bloch & Schn., 1801, 53.
Phycis regalis, Günther, iv, 355.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2021	37 36 00	74 15 00	179

19. Phycis chesteri, Goode and Bean.

Phycis chesteri, Goode & Bean, Proc. U. S. Nat. Mus., i, 1878, p. 256; Cat. Fish Essex Co. and Mass. Bay, 1879, p. 8; Goode, Proc. U. S. Nat. Mus., iii, p. 476.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2014	36 41 05	74 38 55	373
2025	40 02 00	70 22 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 42 00	209
2061	42 10 00	66 47 45	115
2089	39 58 50	70 39 40	168
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197

20. Haloporphyrus viola, Goode & Bean.

Haloporphyrus viola, Goode & Bean, Proc. U. S. Nat. Mus., i, pp. 257–260, Dec. 17, 1878.

Taken at the following stations:

Station.	North latitude.	West longitude.	Depth.
	° ′ ″	° ′ ″	
2030	39 29 45	71 43 00	588
2035	39 26 16	70 02 37	1,362
2051	39 41 00	69 20 20	1,106
2052	39 40 05	69 21 25	1,098
2072	41 53 00	65 35 00	858
2075	41 40 30	65 35 00	855
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2083	40 26 40	67 05 15	959
2084	40 16 50	67 05 15	1,290
2094	39 44 30	71 04 00	1,022
2095	39 29 00	70 58 40	1,342
2096	39 22 20	70 52 20	1,451
2102	38 44 00	72 38 00	1,209
2103	38 47 20	72 37 00	1,091
2105	37 50 00	73 03 50	1,395
2111	35 09 50	74 57 40	938
2115	35 49 30	74 34 45	843
2116	35 45 23	74 31 25	888

21. **Merlucius bilinearis**, (Mitch.) Gill.

Stomodon bilinearis, Mitchill, Rep. Fish. N. Y., 1814, p. 7.
Merlucius bilinearis, Gill, Cat. Fish. E. Coast N. A., 1861, p. 48.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2014	36 41 05	74 38 55	373
2020	37 37 50	74 15 30	143
2025	40 02 00	70 27 00	239
2027	39 58 25	70 37 00	198
2052	42 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2058	41 57 30	67 58 00	35
2061	42 10 00	66 47 45	115
2081	41 10 20	66 30 20	50
2085	40 05 00	70 34 45	70
2086	40 05 05	70 35 00	69
2087	40 06 50	70 34 15	65
....	40 01 50	70 39 20	111
2089	39 58 50	70 39 40	168
2090	39 59 40	70 41 10	140
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197
....	40 05 00	70 34 45	70

22. **Onos rufus**, Gill, new species.

Onos rufus, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 259.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2051	39 41 00	69 20 20	1,106
2072	41 53 00	65 35 00	858

23. **Onos cimbrius**, (Linn.) Goode & Bean.

Gadus cimbrius, Linn., Syst. Nat., ed. xii, 1766, p. 440.
Onos cimbrius, Goode & Bean, Proc. U. S. Nat. Mus., i, p. 349, Feb. 14, 1879.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2015	37 31 00	74 53 30	19

24. **Gadus morrhua**, Linnæus.

Gadus callarias et morrhua, Linn., Syst. Nat.; Günther, iv, 328.
Morrhua americana, Storer, Hist. Fish. Mass., 343.
Gadus macrocephalus, Tiles., Mem. Acad. Sci., St. Petersb., ii, 360, 1810.
Gadus macrocephalus, Günther, iv, 330.
Gadus ogak, Richardson, F. B. A., Fish, 246.
Gadus ogac, Bean Bull. U. S. Nat. Mus., xv, 110.
Gadus auratus, Cope, Proc. Am. Philos. Soc. Phila., 1873.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2057	42 01 00	68 00 30	86
2058	41 57 30	67 58 00	35
2061	42 10 00	66 47 45	115
....	41 07 30	71 07 00	*18

* Cox Ledge.

25. Brosmius brosme, (Müller) White.

Gadus brosme, Müller, Prodr. Zoöl., Dan., 41, 1776.
Gadus brosme, Fabr. Faun. Grœnl., 140.
Brosmius flavescens, Günther, iv, 369.
Brosmius flavescens, Storer, Fish. Mass., 368.
Brosmius brosme, Günther, iv, 369.
Brosmius vulgaris, De Kay, New York Fauna, Fish., 289.

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2061	42 10 00	66 47 45	115
2064	42 25 40	66 08 35	122

26. Pollachius carbonarius, Gill.

Gadus virens and *G. carbonarius*, Linn., Syst. Nat.
Merlangus purpureus, Storer, Fish. Mass., 358.
Gadus virens, Günther, iv, 339.
Pollachius carbonarius, Gill.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2031	39 29 00	72 19 55	74

LYCODIDÆ.

27. Lycodes verrillii, Goode & Bean.

Lycodes verrillii, Goode & Bean, Amer. Jour. Sci. and Arts, vol. xiv, Dec., 1877, pp. 474–476.

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2072	41 53 00	65 35 00	858
2094	39 44 30	71 04 00	1,022

28. Lycodonus mirabilis, new species.

Lycodonus mirabilis, Goode & Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2018	37 12 22	74 20 04	788
2037	38 53 00	69 23 30	1,731
2051	39 41 00	69 20 30	1,106
2074	41 43 00	65 21 50	1,309
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2094	39 44 30	71 04 00	1,022
2105	37 50 00	73 03 50	1,395
2115	35 49 30	74 34 45	843
2116	35 45 23	74 31 25	888

29. Melanostigma gelatinosum, Günther.

Melanostigma gelatinosum, Günther, Proc. Zoöl. Soc. London, 1881, part 1, Jan. 4, p. 21 (genus, p. 20), pl. ii, fig. A.

Taken at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2001	37 46 30	74 00 00	519

TRIGLIDÆ.

30. Prionotus punctatus, (Bloch) Cuv. & Val.

Trigla punctata, Bloch, Ausl. Fisch. taf., 352; ? Cuv. & Val., iv, 93; ? Günther, ii, 193; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 373.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2007	35 17 00	75 13 00	5

31. Prionotus carolinus, Günther.

Prionotus carolinus, Günther, ii, 192.
Prionotus carolinus, C. & V., iv, 90.
Prionotus palmipes and *P. pilatus*, Storer, Fish. Mass., 18.
Prionotus pilatus, Storer, Proc. Bost. Soc. Nat. Hist., ii, 77.
? ? *Trigla carolina*, Linnæus, Mantissa, ii, 528.
Trigla palmipes, Mitchill, Trans. Lit. and Phil. Soc. N. Y., i, 431, 1815.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2081	41 10 20	66 30 20	50

AGONIDÆ.

32. **Peristedium miniatum**, Goode.

Peristedium miniatum, Goode, Proc. U. S. Nat. Mus., iii, pp. 349, 350, Nov. 23, 1880.

Taken at the following station (3 specimens):

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2004	37 19 05	74 26 06	98

33. **Aspidophoroides monopterygius**, (Bloch) Storer.

Cottus monopterygius, Bloch, Ausl. Fisch., ii, 156; taf., 178; Günther, ii, 216.

Taken at the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2062	42 17 00	66 37 15	150
2064	42 25 40	66 08 35	122
2067	42 15 25	65 48 40	122
2079	41 13 00	66 19 50	75

COTTIDÆ.

34. **Hemitripterus americanus**, (Gmelin) Cuv. & Val.

Scorpæna americana, Gmel., Syst. Nat., 1788, 1220.

Cottus acadian, Walbaum, Artedi, Pisc., 1792, 392; Cuv. & Val., iv, 268; Günther, ii, 143.

Hemitripterus acadianus, Storer, Hist. Fish. Mass., 35.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2083	42 02 00	68 27 00	105

35. **Cottus æneus**, Mitchill.

Cottus æneus, Mitchill, Trans. Lit. & Phil. Soc. N. Y., i, 1815, 380; Goode & Bean, Bull. Essex Inst., 1879, 13.

Cottus mitchilli, Günther, ii, 164.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2057	42 01 00	68 00 30	86
2058	41 57 30	67 58 00	35
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2063	42 23 00	66 23 00	141
2067	42 15 25	65 48 40	122
2081	41 10 20	66 30 20	50

36. Icelus uncinatus, (Reinh.) Kröyer.

Cottus uncinatus, Reinh., Vid. Selsk. Natur. og Math., Afhandl. 1833, 44.
Centridermichthys uncinatus, Günther, ii, 172.
Icelus uncinatus, Kröyer, Naturh. Tidsskr. 1844, 253.

Taken at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2068	42 03 00	65 48 40	131

37. Cottunculus microps, Collett.

Cottunculus microps, Collett, Norges Fiske, Appendix to Forh. Vidensk. Selskab. Christiania, 1874, p. 20, pl. 1, figs. 1–3; Norske Nordhavs-Expedition, Fiske, 1880, p. 18, pl. 1, figs. 5 and 6.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2028	39 57 50	70 42 00	209
2030	39 29 45	71 43 00	588
2072	41 53 00	65 35 00	858
2078	41 11 30	66 12 20	499
2092	39 58 35	71 00 30	197
2115	35 49 30	74 34 45	843

SCORPÆNIDÆ.

38. Sebastes marinus, (L.) Lütken.

Perca marinus, L., Syst. Nat., x, 1758, in part.
Perca norvegica, Müller, Zöol. Dan., 46.
Sebastes norvegicus, Günther, ii, 95.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2025	40 02 00	70 27 00	239
2053	42 02 00	68 27 00	105
2061	42 10 00	66 47 45	115
2067	42 15 25	65 48 40	122

39. Sebastoplus dactylopterus, (De la Roche) Gill.

Scorpæna dactyloptera, De la Roche, Ann. Mus., xiii, pl. 22, fig. 2 (*fide* Günther, Cat. Fish. Brit. Mus., ii, p. 99).
Sebastoplus dactylopterus, Gill, M. S.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	373
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2088	39 59 15	70 36 30	143
2090	39 59 40	70 41 10	140
2092	39 58 35	71 00 30	197
2109	35 14 20	74 59 10	142

CARANGIDÆ.

40. **Caranx pisquetus**, Cuv. & Val.; Cuv. & Val., ix, 97.

Caranx hippos, Holbr., Ichth. S. C., 1860, 90.
Paratractus pisquetus, Gill, Proc. Acad. Nat. Sci. Phila., 1862, 432.
Caranx chrysos, Günther, ii, 445.

Taken at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2107	35 19 30	75 15 20	16½

STROMATEIDÆ.

41. **Stromateus triacanthus**, Peck; Peck, Mem. Amer. Acad., ii, 48.

Rhombus cryptosus, Cuv. & Val., ix, 408; Günther, ii, 398.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2102	38 44 00	72 38 00	1,209

CORYPHÆNIDÆ.

42. **Coryphæna sueuri**, Cuv. & Val.

Coryphæna sueuri, C. & V., ix, 302.
Coryphæna globiceps, De Kay, N. Y. Fauna, Fish., 1842, 132.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
....	38 19 26	68 20 30	Surface; speared by grains.
2110	35 12 10	74 57 15	Do.

BERYCIDÆ.

43. **Plectromus suborbitalis**, Gill, new species.

Plectromus suborbitalis, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 258.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2036	38 52 40	69 24 40	1,735
2094	39 41 30	71 04 00	1,022

44. **Stephanoberyx monæ**, Gill, new species.

Stephanoberyx monæ, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 258.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2077	41 09 40	65 55 00	1,253

45. Caulolepis longidens, Gill, new species.

Caulolepis longidens, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 258.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2034	39 27 10	69 56 20	1,346

SYNODONTIDÆ.

46. Bathysaurus agassizii, Goode & Bean.

Bathysaurus, Günther, Ann. & Mag. Nat. Hist., Aug., 1878, p. 181.

Bathysaurus agassizii, G. & B., Bull. Mus. Comp. Zoöl., Harvard College, vol. x, No. 5, p. 214.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2095	39 29 00	70 58 40	1,342
2105	37 50 00	73 03 50	1,395

ALEPOCEPHALIDÆ.

47. Alepocephalus agassizii, Goode & Bean.

Alepocephalus agassizii, G. & B., Bull. Mus. Comp. Zoöl., Harvard College, vol. x, No. 5, p. 218.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2030	39 29 45	71 43 00	588
2051	39 41 00	69 20 20	1,106
2072	41 53 00	65 35 00	858
2075	41 40 30	65 35 00	855
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2103	38 47 20	72 37 00	1,091

48. Alepocephalus productus, Gill, new species.

Alepocephalus productus, Gill, Proc. U. S. Nat. Mus., vol. vi, pp. 256, 257.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2035	39 26 16	70 02 37	1,362

HALOSAURIDÆ.

49. Halosaurus macrochir, Günther.

Halosaurus macrochir, Günther, Ann. & Mag. Nat. Hist., 5th ser., ii, 1878, p. 251.

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2034	39 27 10	69 56 20	1,346
2050	39 42 50	69 21 20	1,050
2051	39 41 00	69 20 20	1,106
2052	39 40 05	69 21 45	1,098
2074	41 43 00	65 21 50	1,309
2077	41 09 40	66 02 20	1,255
2084	40 16 50	67 05 15	1,290
2095	39 29 00	70 58 40	1,342
2096	39 22 20	70 52 20	1,451
2102	38 44 00	72 38 00	1,209
2103	38 47 20	72 37 00	1,091
2106	37 41 20	73 03 20	1,497
2111	35 09 50	74 57 40	938
2116	35 45 23	74 31 25	888

50. Halosaurus goodei, Gill, new species.

Halosaurus goodei, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 257.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2035	39 26 16	70 02 37	1,362

STOMIATIDÆ.

51. Stomias ferox, Reinhardt.

Stomias ferox, Reinhardt, Vid. Selsk. Nat. og Math., Afhandl. x, p. lxxviii.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2095	39 29 00	70 58 40	1,342

52. Hyperchoristus tanneri, Gill, new species.

Hyperchoristus tanneri, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 256.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2083	40 26 40	66 58 00	956

STERNOPTYCHIDÆ.

53. Sternoptyx diaphana, Hermann.

Sternoptyx diaphana, Hermann, Naturforscher, xvi, p. 781, p. 8, Taf. i, figs. 1 and 2; xvii, p. 249 (copied by Walbaum, Artedi, iii, vol. i, figs. 1 and 2, and by Schneider, p. 494, pl. xxxv); Cuvier, Règne Animal, 2d ed., pl. xiii, fig. 1; Cuvier and Valenciennes Hist. Nat. Poiss., xxii, p. 415; Günther, Cat. Fish. Brit. Mus., v, p. 387 (no specimens).

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2034	39 27 10	69 56 20	1,346
2036	38 52 40	69 24 40	1,735
2040	38 35 13	68 16 00	2,226
2044	40 00 30	68 37 20	1,067
2045	40 04 20	68 43 50	373
2047	40 02 30	68 49 40	389
2101	39 18 30	68 24 00	1,686
2102	38 44 00	72 38 00	1,209

54. Argyropelecus hemigymnus, Cocco.

Argyropelecus hemigymnus, Cocco, Giorn. Sc. Sic., 1829, fasc. 77, p. 146; Bonaparte, Faun. Ital. Pesc.; Cuv. and Val., Hist. Nat. Poiss., xxii, p. 398; Günther, Cat. Fish. Brit. Mus., v, p. 385.

Sternoptyx hemigymnus, Valenciennes in Cuvier, Règne Animal, Ill. Poiss., pl. 103, fig. 3.

Sternoptyx mediterranea, Cocco, Giorni il Faro, 1838, iv, p. 7, fig. 2; Bonaparte, Faun. Ital. Pesc., fig. —.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2043	39 49 00	68 28 30	1,467
2074	41 43 00	65 21 50	1,309
2075	41 40 30	65 35 00	855
2076	41 13 00	66 00 50	906
2101	39 18 30	68 24 00	1,686
2111	35 09 50	74 57 40	938

55. Cyclothone lusca, Goode & Bean.

Cyclothone lusca, Goode & Bean, Bull. Mus. Comp. Zoöl. Harvard College, vol. x, No. 5, p. 221.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2094	39 44 30	71 04 00	1,022
2095	39 29 00	70 58 40	1,342
2097	37 56 20	70 57 30	1,917
2099	37 12 20	69 39 00	2,949
2100	39 22 00	68 34 30	1,628
2101	39 18 30	68 24 00	1,686
2105	37 50 00	73 03 50	1,395
2106	37 41 20	73 03 20	1,497
2110	35 12 10	74 57 15	516

SCOPELIDÆ.

56. Scopelus mülleri, (Gmelin) Collett.

Salmo mülleri, Gmelin's Linnæus, Systema Naturæ, i, 1788, p. 1378.

Scopelus glacialis, Reinhardt, Oversigt Kgl. D. Vid. Selsk. Nat. Math. Afh. vi, p. cx., Copenhagen, 1837.

Scopelus mülleri, Collett, Norges Fiske, Tillaegsh. til. Forh. Vid. Selsk., Christiania, 1874, p. 152. Norske Nordhavs-Expedition, 1876–1878, Fiske, 1880, p. 158.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2001	37 46 30	74 00 00	499½
2002	37 20 42	74 17 36	641
2003	37 16 30	74 20 36	641
2014	36 41 05	74 38 55	373
2023	37 48 00	74 01 30	377
2034	39 27 10	69 56 20	1,346
2036	38 52 40	69 24 40	1,735
2039	38 19 26	68 20 20	2,369
2045	40 04 20	68 43 50	373
2047	40 02 30	68 49 40	389
2074	41 43 00	65 21 50	*1,309
2075	41 40 30	65 35 00	855
2076	41 13 00	66 00 50	906
2094	39 44 30	71 04 00	1,022
2097	37 56 20	70 57 30	1,917
2099	37 12 20	69 39 00	2,949
2100	39 22 00	68 34 30	1,628
2101	39 18 30	68 24 00	1,686

* Surface.

SYNAPHOBRANCHIDÆ.

57. Synaphobranchus pinnatus, (Gronow) Günther.

Muræna pinnata, Gronow, Syst. ed. Gray, p. 19 (*fide* Günther).

Synaphobranchus pinnatus, Günther, Cat. Fish. Brit. Museum, viii, p. 23.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2002	37 20 42	74 17 36	641
2003	37 16 30	74 20 36	641
2025	40 02 00	70 27 00	239
2048	40 02 00	68 50 30	547
2072	41 53 00	65 35 00	*858
2075	41 40 30	65 35 00	855
2078	41 11 30	66 12 20	499
2083	40 26 40	67 05 15	959
2096	39 22 20	70 52 20	1,451
2115	35 49 30	74 34 45	843
2116	35 45 23	74 31 25	888
2110	35 12 10	74 57 15	516
2106	37 41 20	73 03 20	1,497

* In stomach of Macrurus.

58. **Histiobranchus infernalis**, Gill, new species.

Histiobranchus infernalis, Gill, Proc., U. S. Nat. Mus., vol. vi, p. 255.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2037	38 39 30	69 08 25	1,731

NEMICHTHYIDÆ.

59. **Nemichthys scolopaceus**, Richardson.

Nemichthys scolopaceus, Richardson, Voyage Samarang, Fishes, p. 35, pl. x, figs. 1, 3 (*fide* Günther, Cat. Fish. Brit. Mus., viii, p. 21).

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2001	37 46 30	74 00 00	519
2002	37 20 42	74 17 36	641
2003	37 16 30	74 20 36	641
2023	37 48 00	74 01 30	377
2039	38 19 26	68 20 20	2,369

50. **Serrivomer beanii**, Gill, new species.

Serrivomer beanii, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 261.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2075	41 40 30	65 28 30	855

61. **Spinivomer goodei**, Gill, new species.

Spinivomer goodei, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 261.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2039	38 19 36	68 20 20	2,361

62. **Labichthys carinatus**, Gill, new species.

Labichthys carinatus, Gill, Proc. U. S. Nat. Mus., vol. vi, pp. 261, 262.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2076	41 13 00	65 33 30	906

63. Labichthys elongatus, Gill, new species.

Labichthys elongatus, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 262.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2100	39 22 00	68 34 30	1,628

NOTACANTHIDÆ.

64. Notacanthus analis, Gill, new species.

Notacanthus analis, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 255.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2037	38 30 30	69 08 25	1,731

65. Notacanthus phasganorus, Goode.

Notacanthus phasganorus, Goode, Proc. U. S. Nat. Mus., iii, 535, 1880.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2048	40 02 00	68 50 30	547

XIPHIIDÆ.

66. Xiphias gladius, Linnæus.

Xiphias gladius, Linn., Syst. Nat.; Günther, ii, 511; Storer, Fish. Mass, 1867, 71.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2091	40 01 50	70 59 00	*117

* Trawl-line.

CHAULIODONTIDÆ.

67. Chauliodus sloani, Bloch & Schneider.

Chauliodus sloani, Bloch & Schn., 430; Günther, v, 392.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2001	37 46 30	74 00 00	519
2002	37 20 42	74 17 36	641
2003	37 16 20	74 20 36	641
2094	39 44 30	71 01 00	1,022

68. Sigmops stigmaticus, Gill, new species.

Sigmops stigmaticus, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 256.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2039	38 19 26	68 20 20	2,361

Leptocephalidæ.

69. Leptocephalus sp. (perhaps larva of Synaphobranchus).

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2104	38 48 00	72 40 30	991

Anguillidæ.

70. Conger oceanicus, Gill.

Conger oceanicus, Gill, Rept. Com. Fish for 1871–'72, 811.
Conger vulgaris, Günther, viii, 38.
Conger occidentalis, De Kay, N. Y. Fauna, Fish, 314, 1842.
Anguilla oceanica, Mitchill, Jour. Acad. Nat. Sci., i, 407.
Conger vulgaris, Cuvier, Règne Anim, 1817.
Muræna nigra, Risso, Ichth. Nice, 1810, 93.
Anguilla conger, L. Syst. Nat.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	373
2031	39 29 00	72 19 55	74

71. Simenchelys parasiticus, Gill.

Simenchelys parasiticus, Gill, MS. in Goode & Bean, Bull. Essex Inst., xi, 27, 1878.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2030	39 29 45	71 43 00	588

EURYPHARYNGIDÆ.

72. Gastrostomus bairdii, Gill and Ryder.

Gastrostomus bairdii, Gill & Ryder, Proc. U. S. Nat. Mus., vol. vi, pp. 262–273.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2043	39 49 00	68 28 30	1,467
2047	40 02 30	68 49 40	389
2074	41 43 00	65 21 50	1,309
2096	39 22 20	70 52 20	1,451
2101	39 18 30	68 24 00	1,686

PETROMYZONTIDÆ.

73. Petromyzon (Bathymyzon) bairdii, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 254.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2048	40 02 00	68 50 30	547

74. Petromyzon marinus, Linnæus.

Petromyzon marinus, L. Syst, Nat.; Günther, viii, 501; Jordan, 348.
Petromyzon americanus, Le Sueur, Trans. Am. Philos. Soc., i, 383.
Petromyzon americanus, Storer, Fish. Mass., 251.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2048	40 02 00	68 50 30	547

MYXINIDÆ.

75. Myxine glutinosa, Linnæus.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2078	41 11 30	66 12 20	499
2086	40 05 05	70 35 00	69
2088	39 59 15	70 36 30	143
2089	39 58 50	70 39 40	168
2092	39 58 35	71 00 30	197

CHIMÆRIDÆ.

76. Chimæra abbreviata, Gill, new species.

Gill, Proc. U. S. Nat. Mus., vol. vi, p. 254.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2084	40 16 50	66 58 00	1,290

RAIIDÆ.

77. Raia eglanteria, Lacépède.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2011	36 38 30	74 40 10	81
2015	37 31 00	74 53 30	19
*	40 05 25	70 28 00	90
2053	42 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2081	41 10 20	66 30 20	50
2089	39 58 50	70 39 40	168
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197

* Trawl-line.

78. Raia radiata, Donovan.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2011	36 35 30	74 40 10	81
2015	37 31 00	74 53 30	19
2021	37 36 00	74 15 00	179
*	40 05 25	70 28 00	90
2053	42 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2081	41 10 20	66 30 20	50
2089	39 58 50	70 39 40	168
2092	39 58 35	71 00 30	197

* Trawl-line.

79. Raia ocellata, Mitchill.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
....	40 05 25	70 28 00	*90
2031	39 29 00	72 19 55	*74
2057	42 01 00	68 00 30	86
2081	41 10 20	66 30 20	50
(†)	41 07 30	71 07 00	18

* Trawl-line. † Cox Ledge.

80. Raia lævis, Mitchill.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
....	40 01 50	70 39 20	111
2091	40 01 50	70 59 00	117

SPINACIDÆ.

81. Squalus acanthias, Linnæus.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
...	40 05 25	70 28 00	*90
2031	39 29 00	72 19 55	†74
2032	39 29 00	72 19 40	74

* Trawl-line. † Trawl-line and trawl.

GALEORHINIDÆ.

82. **Scoliodon terræ-novæ**, (Richardson) Gill.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2107	35 19 30	75 15 20	16½
2108	35 16 00	75 02 30	48

SCYLLIIDÆ.

83. **Scyllium retiferum**, Garman.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ′ ″	° ′ ″	
2005	37 18 11	74 27 36	78½
2086	40 05 05	70 35 00	69
2091	40 01 50	70 59 00	117

GENERAL MEDICAL REPORT OF C. G. HERNDON, PASSED ASSISTANT SURGEON, U. S. N.

The U. S. Fish Commission steamer Albatross was built in 1882 by the Pusey and Jones Company of Wilmington, Del. She is constructed of iron; is 234 feet in length over all, 200 feet on a 12-foot water line, $27\frac{6}{12}$ feet beam (molded), $16\frac{9}{12}$ feet depth, net registered tonnage 384; displacement on 12-foot draught, which is her usual draught when ready for sea, 1,000 tons. She is built on the water-tight compartment principle, having six iron bulkheads, five of which are water-tight; these bulkheads divide her into seven compartments, six of which are water-tight. Each bulkhead has a small gate in it, thus allowing, when necessary, water communication between the different compartments. By means of bilge connections, each compartment can be pumped out independently. The ship is supplied with two independent sets of compound engines, which drive right and left handed four bladed screws, and propel her at a maximum speed of 12 knots. The ship is rigged as a brigantine. Upon the main deck is the cabin, deck-house, and pilothouse. The cabin is 38 feet in length, extends across the width of the ship, is $7\frac{2}{12}$ feet below decks, and has a cubic capacity of 2,233 feet; on starboard side forward is an office, abaft this a state-room; corresponding to these on port side is a pantry and state-room; each of these staterooms has a cubic capacity of 580 feet. In each state-room is an 11-inch circular air-port. Between these apartments is a passage-way 5 feet wide. Abaft these is the main cabin. On each side of cabin are two circular air-ports, of same size as those in state-rooms. Cabin skylight is 6 by 5 feet. As in all other parts of ship, artificial light is furnished by the Edison incandescent system; heat is furnished by steam from main boilers, and ventilation by same apparatus as that in use in other parts of the ship. Between cabin and deck-house is a deck space the width of ship and 16 feet long. About center of this space is the wardroom skylight, 7 by 5 feet. The *deck-house*, the top of which forms the hurricane-deck, extends forward for 83 feet, is $13\frac{6}{12}$ feet wide and $7\frac{4}{12}$ feet high. It is built of iron, sheathed with wood as far as the forward fire-room bulkhead. This method of construction serves to protect what may be termed the uncovered hatchways. Forward the fire-room the deck-house is of wood; any hatch in this part can be securely battened down should the necessity arise. In the after part of the deck-house is the stairway leading to the ward-room; forward of this is the engine-room, lighted and ventilated by a door in each side, and a window to a side; the windows in the deck-house are 20 by 26 inches. The engine-room hatch has a windsail, and is $6\frac{2}{12}$ by $4\frac{6}{12}$ feet.

Around the sides and after end of the engine-room is an iron gallery,

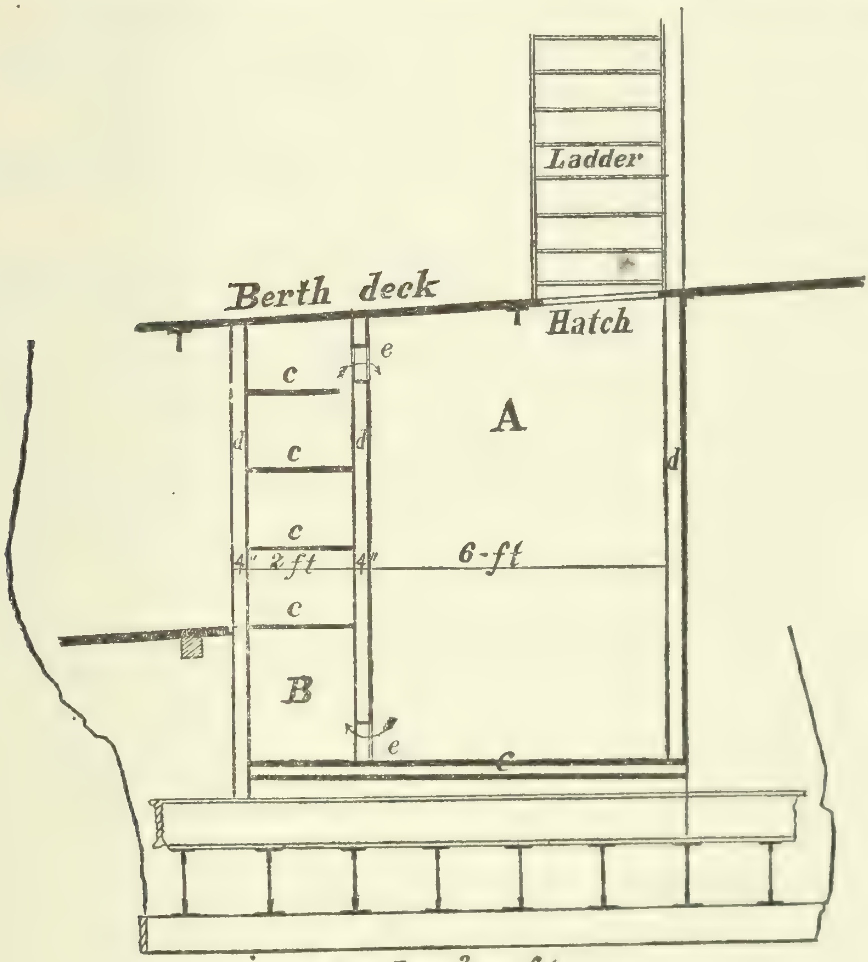
upon the forward port end of which is a Baird's distiller, capable of producing 2,000 gallons of water in twenty-four hours. Forward of the engine-room and immediately over the starting gear of the main engines is the kitchen, which contains a large and improved galley. Next to galley is the upper boiler-room, and forward of this are four state-rooms, two on each side, which are the quarters for members of the Fish Commission. These rooms are exceedingly well lighted and ventilated, each one having a large door and window opening from the gangway. Above each door are a number of apertures communicating with the outside air, and in cold and stormy weather, when doors and windows are closed, there is ample ventilation through these. In addition to these, the longitudinal bulkhead dividing the house has in its upper part perforations of considerable size and number. Cubic capacity of each of these rooms is 306 feet. Next comes the upper laboratory, which has the same beam as the rest of the house, is 13$\frac{9}{12}$ feet long, and has a cubic capacity of 1,249 feet. A hatchway leads from this to lower or main laboratory. In after end of upper laboratory is a large bookcase for a scientific library. To the right of library is a case for scientific instruments, and on opposite side are two large tanks, one for alcohol and one for sea-water. On the starboard side of the forward bulkhead is the medical case, the upper part of which has large glass doors, and contains the dispensing bottles, measures, balance, &c. The lower portion of the case is filled with drawers, sufficient in number and size to contain the admirable outfit of medical and surgical instruments with which the Bureau of Medicine and Surgery has supplied this ship, and medical stores for six months' use. Prof. S. F. Baird has supplied the medical department of the ship with a number of the latest standard works on various medical and surgical subjects. In the center of the room is a large table directly under the skylight, at which four persons can be seated at one time. Along the sides of the room are three folding tables. This apartment is admirably lighted and ventilated by means of one hatch 6$\frac{9}{12}$ by 5 feet, two windows and one door on each side. Immediately below the upper laboratory is the lower or main laboratory, of larger size than the former, as it extends from side to side of the ship, which here has a beam of 26 feet. It is 20 feet long and 7$\frac{10}{12}$ feet between decks. This apartment, as well as the laboratory store-room immediately below, is separated from the rest of the ship by iron water-tight bulkheads, an important matter, as hundreds of gallons of alcohol are kept in them. The after end of this room contains a table for chemical work, and drawers for the storage of chemical apparatus. In the early part of the cruise repeated efforts were made to eliminate the constituent gases of sea-water by means of Behren's apparatus; but the apparatus, when set up, was so easily disarranged by even slight motion of the ship that the attempt was finally given up. The water specimens are now sent for analysis to the Fish Commission laboratories at Washington, D. C., and Wood's Holl, Mass.

The water to be preserved for analysis is brought up in the Sigsbee water-cup from various depths varying from a few fathoms to 2,747 fathoms, the greatest depth from which a specimen has yet been taken on board. As soon as the cup arrives at the surface its contents are poured into water-specimen bottles, with ground-glass stoppers, and over these split skin is carefully tied. Before the specimen bottles are used they are carefully washed out with distilled water. Many specimens of sea-water from varying depths and from various localities are examined on board in order to note the changes in specific gravity of the water under different conditions. The following scheme illustrates the method of recording the examinations:

Date.	Station.	Depth.	Temperature of the water at this depth.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60°.

At frequent intervals copies of the results of these examinations are forwarded to the Fish Commission laboratories. Hilgard's salinometer is the instrument used for determining the specific gravity. On the starboard side of the lower laboratory, aft, is a dark-room for the use of the photographer. On the port side, corresponding to this position, is a large sink supplied with running water, where specimens can be washed. Forward of the sink and dark-room are two long tables, where specimens can be sorted, dissected, &c.; the table on the port side, used by the ichthyologist, is of a convenient height for work while standing, that on the starboard side while seated. Each table is supplied with drawers, where instruments, towels, &c., can be kept. The forward bulkhead of lower laboratory is filled with compartment drawers for holding natural history specimen bottles. Below these drawers are spaces for eight boxes, which contain copper alcohol tanks, which hold 16 gallons. Laboratory store-room is just below. In this are kept large quantities of alcohol in tanks, natural history specimens ready for shipment, a large supply of specimen bottles ready for use, fishing-seines, scoop-nets, harpoons, &c. Forward of upper laboratory is the chart-room and pilot-house. On each side of deck-house is a gangway 6 feet wide. Forward of the pilot-house is the dredging engine, and beyond this a clear deck space in which is the berth-deck hatch. The forecastle is a high one, being 6 feet between decks. Under the forecastle on starboard side are closets for officers and bath-room for crew. On port side are closets for crew and lamp-room. The forecastle affords berths for fourteen of the crew. In cold and stormy weather at night a curtain is lowered from forecastle to main deck. Just below the berth-deck and forward of the forehold is a *cold-room and ice-house.*

The prime object in supplying the Albatross with these was to provide a place where fresh natural-history specimens could be stored and kept without undergoing putrefactive changes. When the cold-room is not in use for this purpose it can be used for the storage of fresh provisions, and has been so utilized during the past year. It is in this connection that I wish particularly to call attention to it, for it would be an easy matter to fit our naval vessels with similar compartments, and as new vessels for the Navy are now being constructed, and it seems not unlikely that more will soon follow, the present seems an opportune time to direct attention to the fact that in this ship these compartments have been in constant use for a year, and are now regarded by all as a practical success. The advantages resulting from the use of fresh food at sea need not be enumerated, and the benefits resulting from having a supply of ice on hand, not alone for dietetic purposes, but for use during the prevalence of many diseases, are equally recognized. The ice-house and cold-room are constructed to work on the cold-blast system. The ice-house and cold-room have the following dimensions: The former is 6 feet and the latter 2 feet in the clear, fore and aft. Each is about 9 feet high, and extends across the entire width of the ship. The ice-house, marked A in the appended figure, is divided



Scale $\frac{3}{16}$ = ft.

by a midship longitudinal bulkhead, making in fact two independent compartments, each capable of holding from 3 to 4 tons, according to the care with which the packing is done. The bulkheads,

top, sides, and bottom are double sheathed, and contain a 4-inch air space, which is filled with sawdust; they are lined on the inside with galvanized iron, and all joints are carefully soldered. A trap in each compartment drains all water into the bilge. The ice-houses are reached by hatches from the berth-deck. The cold-room B is immediately abaft the ice-house and communicates with it by apertures near the top and bottom of the after bulkhead of the ice-house, as shown by the arrows *e*, *e*. Gratings, *c*, *c*, *c*, *c*, which are in sections, and can be easily removed and cleaned, are used as shelves on which the natural history specimens or articles of food can be placed. The structure of the cold-room is precisely similar to that of the ice-house, except that the air-space is filled with hair-felt instead of sawdust. This space, just as in the ice house, is divided by a longitudinal bulkhead, thus allowing two independent compartments, each with its door in the after bulkhead. The air of the ice-house becomes chilled, falls to the bottom of the chamber, and precipitates its moisture, while the air in the cold-room, whose temperature is greater than that of the ice-house, and contains consequently more aqueous vapor, rises; thus a constant current is established between the chambers, and passes through the apertures marked by the arrows. That the air in the cold-room does take up and remove moisture has been shown by the simple experiment of placing wet cloths on the gratings, and which on removal a few hours later were found to be comparatively dry. Fresh food for twenty-five persons for twenty days has been carried, and this quantity could be largely increased. When the ice-house is kept well filled, the temperature of the cold-room is about 40° F.

Berth-deck.—On the forward part of this deck are the magazine, brig, &c. This deck is 40 feet long, $7\frac{10}{12}$ feet between decks, and has a cubic capacity of 16,000 feet; it is laid with yellow-pine lumber which was thoroughly seasoned before it was put into the ship, and consequently its capacity for absorbing and retaining moisture for hours after washing down is limited; the rapidity with which the deck dries can be greatly increased by starting the blowers immediately after drying down, and observations have shown that in a short time after starting these, the atmospheric conditions of berth and spar deck are alike. During the past year this deck has not been wet on an average more than twice a week. On this deck forty-four of the crew swing, and all the men are messed; they are provided with swinging tables and with benches, which can in a very short time be stowed away; the comfort of the crew is immensely promoted by the substitution of tables and benches for mess-cloths. The deck is well lighted and ventilated by two hatches, the larger of which is $6\frac{6}{12}$ by $6\frac{6}{12}$ feet, and a smaller one $3\frac{9}{12}$ by $3\frac{6}{12}$ feet; by four air-ports on each side, circular in shape, and 9 inches in diameter, and by six registers for artificial ventilation. Two steam-pipes, running to and from anchor and reeling engines, pass through this deck; their presence is sometimes an advantage and sometimes

not; in cold and wet weather they assist in keeping the deck dry and warm, but when the ship is at work in tropical climates they increase the temperature. The deck is supplied with two steam-heaters, and its average temperature is about 74° F. On the after part of this deck is the engine for reeling in the wire cable used in dredging operations.

The *steerage* is on the after part of the berth-deck; the apothecary, yeomen, and machinists live here. The steerage consists of a country $12\frac{2}{12}$ feet long and $7\frac{10}{12}$ feet between decks, and four state-rooms, two on a side; each state-room contains two bunks, one above the other; the bunks are 6 feet long. The cubic capacity of the steerage, country, and state-rooms is 2,184 feet. Each state-room has a circular air-port, 9 inches in diameter in the clear, and a register for artificial ventilation. The steam pipes for the anchor, dredging, and capstan engines pass through the steerage, and formerly made it very hot. This has been, to a very great degree, remedied by introducing through the main deck a 12-inch ventilator. The average temperature of these quarters prior to this, when steam was being used on forward engines, was 90° F., and the average now, under same conditions, is 80° F.

The *fire-room* is a very cool one, the average temperature during the year being only 90° F. The engine-room is cool, compared to many naval vessels; the hottest part is about the starting gear, which is just beneath the galley. The average temperature here for the year was 110° F.

The *ward-room* is 38 feet long and $7\frac{10}{12}$ feet between decks. It differs in plan from the usual ward-room in that forward of the state-rooms is a clear space, the entire width of the ship and $12\frac{3}{12}$ feet deep. Abaft this space and on starboard side are three state-rooms and bath-room.

All bunks in this ship, except those in steerage, are $6\frac{6}{12}$ feet long. On port side are four state-rooms. Forward of ward-room, on starboard side, is the chief engineer's room, and on port side is the pantry, with a large store-room beneath. Under ward-room country are the paymaster's and navigator's store-rooms. Over forward part of ward-room is a hatch 7 by 5 feet. In the country are six registers for artificial ventilation, three on a side, and four circular air-ports, 9 inches in diameter, two on each side. Every state-room contains a register for artificial ventilation and one of the circular 9-inch air-ports. The cubic space of the country, state-rooms, and pantry is 4,300 feet. The average size of the state-rooms is 360 cubic feet.

Heating.—All parts of the ship are fitted with radiators supplied with steam from the main boilers.

Ventilation.—Ventilation is effected in part by the natural entrance of air through air-ports, doors, windows, and hatches, and largely by artificial means. The artificial ventilation is effected on the aspiration system by means of a No. 6 Sturtevant exhaust fan, propelled by a Wise steam motor, which is a kind of rotary machine, patented and manufactured by Thomas Wise, of South Framingham, Mass. The motor is

mounted on the fan-shaft without the intervention of any mechanism whatever. The plant is suspended from the under side of the main-deck beams in the boiler-room. The air-opening of the fan is circular, and has a diameter of 14 inches, which is the size of the main conduit. The two main branch conduits, one on each side of the ship, are 11 inches in diameter, and their branches, which run fore and aft the entire length of the ship, commence with a diameter of 9 inches, and diminish in size as they recede from the branch mains until a diameter of 3 inches is reached at the extremities of the hull. The registers are uniform in size, and have an opening of 2½ inches. These openings are regulated by rotary covers on ground faces, whereby they are made air and water tight. The conduits are galvanized-iron spiral pipes, light, and strong enough to bear an internal pressure of 60 pounds. The pipe-joints are riveted and soldered. The system was designed to run at 1,018 revolutions per minute, and at that speed 251,500 cubic feet of air would have been exhausted from the ship, or a mean of 3,007 cubic feet per hour for each of the 75 persons on board. This, in actual practice, has not been realized, however, from lack of power in the motor driving the fan; in fact, not much more than half this volume has been reached. Notwithstanding this, the air in the inhabited parts of the ship is much better than it could possibly be without the artificial ventilation, and the comfort and health of all is thereby promoted. The vitiated air gathered from all parts of the ship is brought, by the system of pipes and conduits already described, to the upper part of the fire-room, where it is discharged with considerable force, and then mingles with the air entering the furnaces. Judging from my own experience during the past year, and from talking with various officers attached to the ship, I think there is but little doubt that the air between decks has been best, and every one has felt most benefit from the artificial ventilation, when the system has run continuously for hours at a time, thus preventing any accumulation of vitiated air, than when it has been run spasmodically, even though a higher rate of speed was maintained for a short time.

Lighting.—The ship is lighted by the Edison incandescent system, using a Z dynamo of 51 volts pressure, and requires about six horse-power from a steam-engine. The current of electricity flows through carbon filaments in vacuo, of 69 ohms resistance in lamps, each of which gives a light equal to 8 candles' power. Some 16-candle lamps are now in use on board. The total number of lamps in the ship is 140. Each state-room is supplied with one. The lamps are mounted on brackets and fixtures resembling gas-fixtures, and are lighted and extinguished by a key, which is much like the stop-cock on a gas jet. The lamps are guaranteed to last for 600 hours; many of those in this ship have been in use since the ship was commissioned, and have burned more hours than they were guaranteed to do. One of them has burned 1,590 hours; several have burned more than 1,200 hours, and the average life has

been 592 burning hours. This average would have been greater, but for the fact that the deck-house is abundantly supplied with lights, many of which are in very exposed positions, and have been accidentally broken long before their burning life was completed. This system of lighting has been to us a source of great comfort, so great, indeed, that it can only be properly appreciated by those who have used flickering candles in state-rooms, and who also know the difficulty with which ships' lamps, as a rule, are kept in good order. In addition to having a brilliant and steady light, it must be remembered that these lamps do not consume any of the oxygen of the air in the quarters below decks, which are necessarily restricted in cubic capacity, but leave it all for purposes of respiration.

In building the ship and in fitting her out neither expense nor pains were spared to make her a comfortable home for officers and men, and experience during the past year has shown her to be a comfortable and healthy ship. During 1883 the ship has been engaged in deep-sea explorations along the Atlantic coast from Cape Hatteras, N. C., to Cape Sable, Nova Scotia. The following ports were visited, several of them more than once: Washington, D. C.; Wilmington, Del.; Norfolk, Va.; New York, N. Y.; Greenport (L. I.), N. Y.; Newport, R. I.; Wood's Holl, Mass.; New Bedford, Mass.; Portsmouth, N. H.; Provincetown, Mass.; Gloucester, Mass.; Baltimore, Md. During the year she has steamed 10,416 miles, and was under steam 327 days. She was under steam, at sea, 108 days; in port, 257 days. There were 83 admissions to the sick-list; of these 77 were discharged to duty; 6 were invalided to the Washington and Norfolk naval hospitals; of these, 3 returned to duty on board and 3 were discharged from the service in the hospitals. One hundred and thirty-seven recruits were examined; of these, 110 were accepted and 27 rejected. The average number of souls on board for the year has been 67; of these, 9 are commissioned officers. There are no marines or apprentice boys in the ship's company.

NAVIGATION REPORT OF LIEUT. SEATON SCHROEDER, U. S. N., NAVIGATOR.

The cruising of the Albatross during this first year of service has been included between the parallels of 35° and 45° north latitude and the meridians of 64° and 77° west longitude. The number of days under way, the object of each trip, and the distances performed are given in the following table:

Date.	Object.	Miles.
December 30, 1882, to January 3, 1883	Wilmington, Del., to Washington, D. C.	339.4
February 10 to February 14	Washington, D. C., to Wilmington, Del.	391.9
March 21 to March 25	Dredging	425.4
April 24 to May 9	Dredging and investigating migrations of mackerel.	1,476.6
May 19 to May 29	do	1,025.1
June 17 to June 19	New York to Washington, D. C	426.1
July 6 to July 14	Investigating migrations of mackerel and menhaden.	816.2
July 18 to July 21	Dredging	446.6
July 25	Newport, R. I., to Wood's Holl, Mass	40.0
July 26 to August 3	Dredging	682.3
August 7 to August 10	Investigating migrations of mackerel and menhaden.	423.3
August 12	Newport, R. I., to Wood's Holl, Mass	40.0
August 13	Wood's Holl, Mass., to New Bedford, Mass	24.0
August 18	New Bedford, Mass., to Wood's Holl, Mass	24.0
August 21 to August 25	Investigating migrations of mackerel and menhaden.	951.1
August 29 to September 7	Dredging	859.5
September 11	Wood's Holl, Mass., to New Bedford, Mass	24.0
September 13	New Bedford, Mass., to Wood's Holl, Mass	24.0
September 20 to September 22	Dredging	263.5
September 30 to October 5	do	586.7
October 11	Wood's Holl, Mass., to Newport, R. I.	40.0
October 17 to October 19	Investigating migrations of mackerel and menhaden.	286.5
October 22 to October 25	do	411.7
November 5 to November 14	Dredging	1,020.3
December 28 to December 29	Washington, D. C., to Baltimore, Md	180.0
	Total, 121 days	11,228.2

The principal implements used in the navigation of the vessel comprise five box chronometers (three Negus, one Bliss & Creighton, and one Parkinson & Frodsham), one Negus pocket chronometer, four Ritchie liquid compasses (of which two are of the Navy Department design), one Rogers portable micrometer telescope, and one Walker's and one Bliss's patent log. These taffrail logs give perfect satisfaction if care is taken to keep them oiled and not to strike the propeller against the ship in hauling in; they constitute the only means used for measuring the speed of this ship through the water.

The standard compass was placed on top of the deck-house, 15¾ feet forward of the smoke-stack, 3 feet 11 inches above the deck. Lieut. Commander T. A. Lyons, U. S. N., superintendent of compasses, Navy Department, had found this to be the position where the needle was least disturbed by the various magnetic forces exerted by the metal of and in the ship; it is also in a convenient position for use, being handy

for taking bearings and under the eye of the officer of the deck when under way.

In the month of April the local deviations were ascertained by azimuths of the sun taken on every point, the ship being upright and swung by the helm under steam. One circle was made with starboard helm and one with port helm, the mean of the results being accepted as correct. The curve of deviations for compass courses was plotted upon the Napier diagram, and a table of deviations for magnetic courses was deduced for convenience in laying the ship's head. In the accompanying steering card the points of the inner circle represent *correct magnetic* courses, which are joined by radiating curved lines to the corresponding *compass* courses at the outer circle.

Example.

To make a magnetic course east, steer by standard compass ESE. ⅛ E.

The ship was also swung once while listed 4° to 6° to starboard and once while listed 4° to 6° to port, azimuths being taken on every alternate point. The greatest changes from the even-keel deviations were on the NNE. and SSW. courses, the deviations on those courses when listed to starboard being respectively 10° 11′ W. and 17° 41′ E., instead of 3° 03′ W. and 8° 20′ E., as on an even keel. When listed to port the deviations on these courses were 6° 10′ W. and 12° 44′ E., respectively, instead of 3° 03′ W. and 8° 20′ E., as on an even keel.

In general terms, it may be stated that the changes of deviations due to inclination are such that when heeled to starboard the ship's head is thrown to windward, or towards the higher side, when on any course in the northern semicircle; in the southern semicircle, when heeled to starboard, the ship's head is thrown to leeward, or towards the lower side.

When heeled to port the ship's head is thrown to leeward when on any course between southeast and northwest through north, and to windward when on any course to the southward of southeast and northwest.

At the same time that the ship was swung as above described, vibrations of vertical and horizontal needles at the position of the standard compass were observed on the various courses by Lieutenants Richard Wainwright and S. W. B. Diehl, U. S. N., on duty in the office of the superintendent of compasses, Navy Department, to obtain the mean values of λ and μ. The results of their observations will be published by the Bureau of Navigation, Navy Department.

This examination was made in latitude 38° N., off Point Lookout, at the mouth of the Potomac River, which ground affords every advantage in point of space and smooth water.

Lieutenants Wainwright and Diehl also made a magnetic survey of the vessel in the month of June, while in the dry-dock of the navy-yard, New York.

The ship's head, while building, was toward north, 29° 30′ W.; the ways were in latitude 39° 44′ N., longitude 75° 33′ W.

Of the chronometers on board, the Bliss & Creighton was loaned by the Navy Department, the Parkinson & Frodsham is the property of the commanding officer, and the Negus pocket chronometer, of the navigator. The box chronometers were placed under the lounge in the chart-room, the transporting cases being screwed to a false bottom on the deck. In this position they are secure from shocks, and the top of the lounge, opening and shutting on hinges, fits tightly enough to prevent any great changes of temperature. The lowest mean temperature between ratings during the year has been 57.4° F., and the highest 76° F. On deck the extremes have been 14° and 96°. The interval between ratings has usually been ten to twenty-five days.

The most powerful disturbing element on the rates of the chronometers has been the vibration of the hull caused by the dynamo engine, which is usually in operation from dark until 11 p. m. They appear to run equally well together while this vibration takes place every day, and during any material interval that it does not take place at all, but an interruption of either state of repose or vibration is almost invariably accompanied by a change in the second differences in the daily comparison book, showing that their rates are temporarily disturbed.

The dates of last cleaning of the chronometers are as follows: Bliss & Creighton, No. 1078, June, 1883; Parkinson & Frodsham, No. 1541, March, 1883; Negus, No. 1673, March, 1883; Negus, No. 1674, March, 1883; Negus, No. 1696, March, 1883; Negus, No. 3702 (pocket), October, 1880.

Ordinarily the Bliss & Creighton has been used for every-day work, the mean of all being taken when greater accuracy was required. On reaching port the chronometers are rated as soon as possible, and the errors corrected back if the discrepancy is greater than the probable limits of personal and instrumental errors of observation and plotting.

The Rogers portable micrometer telescope, loaned by the Bureau of Navigation, Navy Department, is a very reliable and a very useful instrument. A description and method of using it is to be found in the revised edition of Bowditch's Navigator, page 177. A modification of that method has been adopted in this vessel, by which less computation is required and the necessity is avoided of picking out each time the log. cotangent of such a small angle. It is as follows:

The greatest angle this instrument can measure is 1,750 micrometer divisions, or about 1° 45′, and it is seldom that an angle of over one-half or three-quarters of that is observed with it. In such small angles the functions may be considered as proportional to the arcs; that is, the cotangent of the angle measured is equal to the cotangent of one micrometer division divided by the number of those divisions. The log. cotangent of one division being accurately determined once for all, the rule for finding the distance is simply to add that function to the loga-

rithm of the height, and from the sum subtract the logarithm of the number of divisions.

The accuracy of this short method is shown in the following example, which is an extreme case:

Example.

A light-house 200 feet high is found to subtend an angle of 1,700 M. D. The value of one division of the instrument in this vessel is 3″.655, of which the log. cotangent is 4.7515377, or in practice 4.75154.

Short method.

200 feet	log.	2.30103
1 M. D.	log. cot.	4.75154
		7.05257
1,700 M. D	log.	3.23045
6,639.3 feet	log.	3.82212

Rigorous method.

$3''.655 \times 1{,}700 = 6{,}213''.5 = 1^\circ\ 43'\ 33''.5.$

200 feet	log.	2.30103
1° 43′ 33″.5	log. cot.	1.52097
6,637.4 feet	log.	3.82200

The smaller the angle, of course the smaller will be the discrepancy.

For rapid work in a hydrographic survey or reconnaissance 10 feet is found to be a convenient length of staff to handle, and the logarithm of 10 being 1.00000, makes the computation all the easier. A board 10 inches broad, painted white, with a 2-inch black stripe down the middle, will be found to be an easily distinguished target.

In the navigation of the Albatross and the location of dredging and other stations, Sumner's method of finding the position at sea is used *in extenso*. All positions, however determined, are plotted as lines, and not as points, the intersection of two such lines, corrected for the intervening run and current, defining the exact position. The lines of position consist of portions of circles of equal altitude of the sun, moon, stars, and planets; parallels of latitude deduced from meridian or ex-meridian altitudes of the same bodies; lines of bearings of head-lands or well-known objects on shore; circles of equal distance from known objects, found by micrometer or by their dipping below the horizon.

Whenever practicable, the errors of the chronometer are found by comparison with the time obtained by telegraphic connection with some observatory clock. When such connection is not feasible, equal altitudes of the sun are taken and computed by Chauvenet's method, either for apparent noon or apparent midnight.

The formula used for determining the latitude from the observed meridian altitude of any heavenly body is—

$$L = z + d.$$

For determining the latitude from an altitude near the meridian of any body, the following formula has always been used:

$$\cos z_0 = \sin h + \cos L \cos d \operatorname{versin} t,$$

in which the approximate value of L is used in computing the term

cos] cos *d* versin *t*. A form and examples are to be found in Bowditch's Navigator, page 200. It does not appear in the revised edition.

The formula used for deducing the latitude from an altitude of Polaris, observed at any time, is—

$$L = h - p \cos t,$$

in which h=true altitude,

p=polar distance, expressed in minutes of arc,

t=hour angle=sidereal time—$*$'s R. A.

A form and example are to be found in the revised edition of Bowditch's Navigator, page 118. In practice, however, it has been found simpler to disregard the sign of cos t, merely adding or subtracting the correction p cos t, according as t is more than 6 and less than 18 hours, or the reverse.

For determining the circles of equal altitude of any body, the hour angle for each latitude is obtained from single altitudes by the ordinary formula—

$$\sin \tfrac{1}{2}\, t = \sqrt{\frac{\cos S \sin (S - h)}{\cos L \cos p}}$$

in which $S = \frac{1}{2}(h + L + p)$.

In addition to the above-mentioned methods, advantage is taken whenever possible of the simple problem of finding the exact distance from an object by reading the taffrail log when it bears exactly four points off the bow, and again when it bears exactly abeam; the distance from the object at the second bearing being equal to the distance run between the two plus or minus the current.

The current at each sounding is carefully estimated by noting the direction and speed of the ship necessary to keep the sounding wire vertical after the shot has passed below the surface current. A fair guide is thus afforded to what allowance should be made in shaping the course to the next position, as well as in connecting the run up to that point. Such help is particularly desirable when clouds by day, or clouds or the absence of the moon at night, prevent taking frequent observations.

Case I.—On April 28 single altitudes of the sun were observed at 6.43 a. m., 8.47 a. m., and 10.23 a. m., a sounding being taken at the time of each sight. The meridian altitude was observed at noon. The three time sights were worked out for latitudes 35° 20′ N. and 35° 30′ N., placing the vessel respectively on the lines AA, BB, CC (accompanying chart, see Plate); and the meridian altitude placed her in latitude 35° 31′ 35″, DD. From the first sounding, ran 10 miles ESE. (mag.) to the second, where the temperature of the surface water and the current showed that the edge of the Gulf Stream had been reached. From the second to the third the drift in trawling and current were estimated at 3 knots NE. From the end of the third cast to noon the drift and current were about 2 miles NNE. These being plotted place the ship in the positions 1, 2, 3, 4.

Case II.—While sounding at about 7 a. m., May 1, a meridian altitude of the moon was observed, showing the latitude to be 36° 41′ 05″ N. At the same time a single altitude of the sun was observed and worked out for latitudes 26° 30′ and 36° 40′. The ship was therefore at the intersection of the two lines thus found, AA, BB. While trawling two more sights of the sun were taken, at 10.09 and 10.49; and being worked out with the same latitudes as before, placed the ship on the lines CC, DD. Finally a meridian altitude of the sun was observed, which placed the ship in latitude 36° 43′ 54″ at noon, EE. The drift while trawling, until the last time sight, was to NW., 2½ to 3 knots in all; and then, after bearing in NW. by W. ½ W., 2¼ miles to noon. No current noticeable. Plotting the track, the ship was found to have been in the positions 1, 2, 3, 4.

Case III.—At 3 and 5.45 p. m., August 1, single altitudes of the sun were observed and worked out for latitudes 39° 40′ N. and 39° 50′, giving lines AA and BB. At about 7.30 an altitude near meridian of * Antares was taken, which placed the ship at that time on the parallel of 39° 39′ 23″, line CC. The drift in trawling during the afternoon was SW., and the distance estimated at 4 knots between the first and second sights and ¾ to 1 knot from the second to the third. No current observed.

Whenever circumstances have been such as to warrant sufficient certainty in the position to give hydrographic value to the soundings taken, lists of them have been furnished to the Hydrographic Office of the Navy Department and the Coast and Geodetic Survey Office of the Treasury Department.

CONCLUSION OF THE YEAR'S WORK.

The work of refitting for our winter's cruise was commenced at once and pushed forward as rapidly as possible. There was but little to do, outside of the ordinary cleaning and painting, except in the engineer's department; there the work was mostly confined to the boilers, which continue to give us trouble.

Paymaster Charles D. Mansfield, U. S. N., reported for duty on the 15th, relieving Paymaster George H. Read.

Hon. W. E. Chandler, Secretary of the Navy, visited the ship on December 20 and inspected the vessel and scientific apparatus. The Naval Advisory Board and other prominent professional men also inspected the vessel and apparatus during her stay at the yard.

At 7.20 a. m., December 28, we left the navy-yard for Baltimore; arrived at 7.45 a. m. the following day, and made fast to the wharf at William Skinner & Son's Marine Railway. We expected to haul out at high water, between 8 and 9 a. m., but as the tide was unusually low, showing 3 feet below mean high water, this was impossible.

On Monday, December 31, there was ample water, and the vessel was taken up without delay. The condition of the submerged portion of the vessel's bottom was very good, considering the nature of the service and the length of time since she was docked.

The Roberts compound, furnished by Devoe & Co., was practically gone from the water-line down to the bilge keels; below this point it was in fair condition. In justice to the composition it should be mentioned that it was applied during very hot weather, and a large portion of it melted and ran off before the vessel was put into the water. The red-lead paint still covered the bottom except on the starboard side, where it had been scraped off by the dredge-rope, red rust forming rapidly on the bare spots thus left. Small barnacles were distributed quite thickly over the bottom, both on the compound and red lead; those growing on the compound were, however, not more than two-thirds the size of those found on the red lead, indicating that their growth had been resisted longer on the former surface or that the compound was less favorable to their development than the red lead.

The benefits derived from the use of the compound were not sufficiently apparent to induce us to continue its use. It is fair to say, however, that had it been applied in cooler weather it would probably have proved more satisfactory.

The bottom was thoroughly cleaned and given a coat of red lead, which was allowed to dry thoroughly; then a coat of white zinc was applied, and given time to dry before the vessel was put into the water.

The following officers were attached to the vessel at the conclusion of this report:

Commissioned officers.

Lieut.-Commander Z. L. Tanner, U. S. N., commanding.
Lieut. Seaton Schroeder, U. S. N., executive officer and navigator.
Lieut. S. H. May, U. S. N.
Lieut. A. C. Baker, U. S. N.
Ensign C. J. Boush, U. S. N.
Ensign R. H. Miner, U. S. N.
Passed Assistant Surgeon C. G. Herndon, U. S. N.
Paymaster C. D. Mansfield, U. S. N.
Passed Assistant Engineer G. W. Baird, U. S. N.

Petty officers.

Charles Wright, master-at-arms.
G. B. Till, equipment yeoman.
N. B. Miller, apothecary.
G. A. Miller, paymaster's yeoman.
F. L. Stailey, engineer's yeoman.
S. M. McAvoy, machinist.
John Hawkins, machinist.
H. R. King, machinist.

Surgeon J. H. Kidder, U. S. N., was relieved April 18 by Passed Assistant Surgeon C. G. Herndon, U. S. N., and Paymaster George H. Read, U. S. N., was relieved by Paymaster C. D. Mansfield, U. S. N., on the 15th of November.

I.—*Dredging and trawling record, U. S. Fish Commission steamer Albatross, Lieutenant-Commander Z. L. Tanner, U. S. N., commanding, season of* 1883.

ABBREVIATIONS FOR KINDS OF BOTTOM.—C. for clay; g. for gravel; m. for mud; oz. for ooze; p. for pebbles; s. for sand; sh. for shells; sp. for specks; st. for stones; blk. for black; brk. for broken; bu. for blue; crs. for coarse; dk. for dark; fne. for fine; glob. for Globigerina; gn. for green; gy. for gray; wh. for white; yl. for yellow.

Date.	Number of observations.	Locality.		Hour.	Temperatures.			Depth.	Kind of bottom.	Wind.		Drift.		Trawl used.
		Latitude north.	Longitude west.		Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
1883.		° ′ ″	° ′ ″		°	°	°	Fathoms.					Miles.	
Mar. 22	2001	37 46 30	74 00 00	3. 22 p. m.	36	......	......	519	Gn. m	NE.	3	NNW.	1. 3	Deep-sea trawl.
23	2002	37 20 42	74 17 36	5. 50 a. m.	36	48	......	641	Gn. m	N.	1	SSW.	1. 3	Beam trawl.
23	2003	37 16 30	74 20 36	8. 44 a. m.	39	50	......	641	....	NE. to E.	1	NW. by W.	2	Do.
23	2004	37 19 45	74 26 06	10. 10 a. m.	45	51	......	102	Gn. m., sh	ENE.	1	SW.	0. 6	Do.
23	2005	37 18 11	74 27 36	11. 52 a. m.	43	50	......	82	Bu. m. and s., brk. sh	ENE.	3	ENE.	0. 5	Do.
23	2006	37 19 11	74 26 06	12. 58 p. m.	40	50	......	512	Bu. m., fne. s	SSW.	4	W. by S.	0. 5	Do.
Apr. 27	2007	35 17 00	75 13 00	8. 00 a. m.	65½	56	68	15	Fne. s.	Var.	0–1	ENE.	2. 0	Do.
27	2008	35 09 40	75 04 36	10. 15 a. m.	67	72	74½	92	Bu. m., fne. s	W.	2	N. by E. ½ E.	1. 0	Do.
28	2009	35 29 35	74 46 45	8. 45 a. m.	64	69	......	531	....	W.	2–3	NE.	2. 5	Deep-sea trawl.
28	2010	35 30 00	74 44 45	10. 40 a. m.	65	61	......	890	....	SW.	3	W. by S.	2. 0	Do.
30	2011	36 38 30	74 40 10	9. 00 a. m.	47	48	......	81	S. and brk. sh	NNE.	3–4	N. by E.	1. 5	Beam trawl.
30	2012	36 41 15	74 39 50	10. 15 a. m.	47	52	......	66½	....	NNE.	3–4	NNE.	1. 5	Rake dredge.
30	2013	36 45 30	74 25 30	1. 05 p. m.	50	48	......	888	Gn. m	NNE.	3	NW.	2. 0	Beam trawl.
May 1	2014	36 41 05	74 38 55	6. 35 a. m.	51½	47	......	373	Gn. m., fne. s	ENE.	4	N.	2. 5	Do.
5	2015	37 31 00	74 53 30	8. 39 a. m.	49	48	......	19	Fne. s. and sh	NE.	3	E. by N.	0. 5	Do.
5	2016	37 31 00	74 52 36	9. 06 a. m	48½	47	45½	19	Fne. s. and sh	NE.	3	E. by N.	1. 0	Do.
5	2017	37 30 48	74 51 24	9. 50 a. m.	47½	46½	45½	18	Fne. s. and sh	NE.	3	....	......	Rake dredge.
7	2018	37 12 22	74 20 04	12. 07 p. m.	62	54	39	788	Bu. m	SW.	2	....	......	Deep-sea trawl.
7	2019	37 13 52	74 23 52	4. 13 p. m.	56½	52¾	39	600	Bu. m	SSW.	2	....	......	Do.
21	2020	37 37 50	74 15 30	5. 30 a. m.	56	54	......	143	Bu. m., fne. s	SE.	3	SW.	1. 5	Beam trawl.
21	2021	37 36 00	74 15 00	7. 00 a. m.	58	54	45	179	Bu. m., fne. s	SE.	3	W. by S.	2. 0	Do.
21	2022	37 32 00	74 13 20	10. 00 a. m.	59	52	40	487	Bu. m	E.	3	SW. by S.	2. 0	Deep-sea trawl.
21	2023	37 48 00	74 01 30	3. 15 p. m.	62	56	......	377	Blk. m., fne. s	SE.	3	NE.	2. 0	Beam trawl.
25	2024	40 02 10	70 27 00	5. 51 a. m.	52	49	40½	222	Dk. gn. m	NNW.	2	NW. by N.	2. 5	Do.
25	2025	40 02 00	70 27 00	7. 20 a. m.	57	49	40½	239	Gn. m., fne. s	NNW.	2	NW. by N.	2. 5	Do.
25	2026	40 04 00	70 28 50	9. 00 a. m.	58	49	48	131	Gn. m. and s	NNW.	2	NW. ½ N.	1. 5	Do.
25	2027	39 58 25	70 37 00	12. 21 p. m.	56	52	43	198	Bu. m. and s	SW.	3	WSW.	2. 5	Do.
25	2028	39 57 50	70 32 00	2. 05 p. m.	56	52	41	209	Bu. m	SW.	3	WSW.	2. 5	Do.
25	2029	39 42 00	70 47 00	5. 13 p. m.	57	53	38½	1, 168	Gy. m	SW.	3–4	WSW.	2	Dredge tangles.
26	2030	39 29 45	71 43 00	6. 20 a. m.	56	49	......	588	Bu. m	SW.	2	SW. ½ W.	2	Beam trawl.
26	2031	39 29 00	72 19 55	1. 05 p. m.	55	50	49½	74	Gy. m., blk. and wh. s.	SSW.	3–4	SE.	1. 5	Do.
26	2032	39 29 00	72 19 40	2. 10 p. m.	55	50	47½	74	Gn. m., fne. s., blk. sp.	SSW.	3–4	S.	1	Do.
26	2033	39 32 30	72 18 35	5. 00 p. m.	62	49½	41	379	Gn. m	SSW.	3–4	ENE.	1	Do.
July 17	2034	39 27 10	69 56 20	8. 55 a. m.	69	72	38	1, 346	Glob. oz	Var.	0–1	WSW.	2. 5	Do.

I.—*Dredging and trawling record, U. S. Fish Commission steamer Albatross, Lieutenant-Commander Z. L. Tanner, U. S. N., &c.*—Continued.

Date.	Number of observations.	Locality. Latitude north.	Locality. Longitude west.	Hour.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Kind of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Distance.	Trawl used.
1883.		° ′ ″	° ′ ″		°	°	°	Fathoms.					Miles.	
July 17	2035	39 26 16	70 02 37	2.50 p. m.	73	71	......	1,362	Glob. oz	SE.	2	SE.	2.3	Beam trawl.
18	2036	38 52 40	69 24 40	4.30 a. m.	82	76	38	1,735	Glob. oz	SE.	3	S.	3.8	Do.
18	2037	38 53 00	69 23 30	1.22 p. m.	79	76	38	1,731	Glob. oz	NE.	2	E.	3.7	Do.
26	2038	38 30 30	69 08 25	2.32 p. m.	77	76½	......	2,033	Glob. oz	NE.	4	NE.	7 5	Deep-sea trawl.
28	2039	38 19 26	68 20 20	Noon.	77½	81	......	2,369	Glob. oz	S.	1	SE.	11	Do.
29	2040	38 35 13	68 16 00	4.20 a. m.	76	76	......	2,226	Glob. oz	SSW.	6	S. by E.	10	Do.
30	2041	39 22 50	68 25 00	3.15 a. m.	71	72	38	1,608	Glob. oz	NW.	3	NW.	10	Do.
30	2042	39 33 00	68 26 45	10.32 a. m.	74	71	38½	1,555	Glob. oz	NW.	4	NW.	12	Do.
30	2043	39 49 00	68 28 30	5.07 p. m.	71	72	38½	1,467	Glob. oz	W.	3	SW.	9	Do.
31	2044	40 00 30	68 37 20	5.25 a. m.	71	72	39	1,067	Oz	W.	2	NW.	7	Do.
31	2045	40 04 20	68 43 50	10.00 a. m.	75	72	40	373	Bu. m., fne. sh	W.	2	WNW.	2.5	Beam trawl.
31	2046	40 02 49	68 49 00	Noon.	74	72	40	407	Bu. m	W.	3	WNW.	2.5	Do.
31	2047	40 02 30	68 49 40	2.15 p. m.	74	72	52	389	Bu. m	W.	3	WNW.	2.5	Deep-sea trawl.
31	2048	40 02 00	68 50 30	3.56 p. m.	73	72	29 ?	547	Crs. s., m., and g	W.	4	ENE.	2	Do.
Aug. 1	2049	39 43 40	69 20 00	3.35 a. m.	71	71	39	1,025	Bu. m	W.	3	W.	3	Do.
1	2050	39 42 50	69 21 20	9.15 a. m.	72	72	44½	1,050	Glob. oz	SW.	3	SW. by S.	3.5	Beam trawl.
1	2051	39 41 00	69 20 20	2.34 p. m.	74	72	39	1,106	Bu. m. and glob. oz	SW. by W.	2	SW.	4	Do.
1	2052	39 40 05	69 21 25	6.16 p. m.	74	73	45	1,098	Glob. oz	SW. by W.	2	SW.	3	Do.
29	2053	42 02 00	68 27 00	5.00 a. m.	60	61	......	105	Bu. m	ESE.	5	NE. by N.	1	Beam trawl.
29	2054	42 03 30	68 26 00	6.20 a. m.	56	64	......	105	Bu. m	E.	6	NE. by N.	1.4	Dredge.
30	2055	42 32 00	68 17 00	9.24 a. m.	60	60	......	99.5	Bu. m., s., and crs. g	E.	3	WSW.	1.5	Do.
30	2056	42 01 30	68 01 00	3.23 p. m.	58	57	......	97	Bu. m., fne. s., and crs. g	E.	3	S.	1	Do.
30	2057	42 01 00	68 00 30	4.26 p. m.	58	57	......	86	Crs. s., blk. sp., brk. sh	NE.	2	S.	2	Beam trawl.
30	2058	41 57 30	67 58 00	6.39 p. m.	58	58	50	35	Gy. s	NNE.	2	SW.	1	Do.
31	2059	42 05 00	66 46 15	5.00 a. m.	56	55	......	41	Bu. m. and s	ENE.	3	SSW.	2	Do.
31	2060	42 10 00	66 46 15	7.10 a. m.	56	55	......	123	Gy. s., blk. sp., brk. sh	NNE.	4	W.	1.5	Do.
31	2061	42 10 00	66 47 45	8.00 a. m.	58	54	40	115	Gy. s., blk. sp., bu. m	NE.	3	NW. by W.	1.5	Do.
31	2062	42 17 00	66 37 15	10.47 a. m.	64	61	42	150	S. and g	NE.	3	NE. by N.	1.5	Do.
31	2063	42 23 00	66 23 00	1.26 p. m.	60	57½	46	141	S. and crs. g	ENE.	3	SE.	1	Do.
31	2064	42 25 40	66 08 35	4.32 p. m.	58	56	......	122	Crs. s. and g	N.	2	SE.	1	Do.
31	2065	42 27 00	66 00 45	7.00 p. m.	60	55	44½	80	S., g., and brk. sh	N.	2	SE. by E.	1	Rake dredge.
Sept. 1	2066	42 19 40	65 49 30	5.00 a. m.	54	54	43½	65	S., st., and g	NE.	3–4	ENE.	1.5	Do.
1	2067	42 15 25	65 48 40	7.05 a. m.	56	56	46	122	S. and g	NE.	4	NE.	2	Beam trawl.
1	2068	42 03 00	65 48 40	10.03 a. m.	60	56	42	131	S., fne. g., and c	ESE.	4	ENE.	2	Do.
1	2069	41 54 50	65 48 35	1.34 p. m.	61	56½	42	101	S., st., g., p. and c	NE.	5	E. by N.	1.5	Grapnel dredge.
1	2070	41 55 30	65 47 10	2.58 p. m.	61	57	42½	113	P. and c	E.	5	N.	1	Bar and tangles.
1	2071	41 56 20	65 48 40	4.10 p. m.	61	57	......	113	P. and c	ENE.	5	N.	1	Grapnel dredge.

	2	2072	41 53 00	65 35 00	6. 15 a. m.	70	56	39	858	Gy. m	S.	3	SE.	5	Beam trawl.
	2	2073	41 54 15	65 39 00	10. 41 a. m.	67	58	40	586. 5	Gy. s	SW.	3	NNE.	2	Do.
	3	2074	41 43 00	65 21 50	6. 42 a. m.	71	69	40	1, 309	M. and st.	WSW.	5	SSE.	4	Do.
	3	2075	41 40 30	65 35 00	3. 41 p. m.	58	58	39	855	Glob. oz	NW.	6	WSW.	2	Do.
	4	2076	41 13 00	66 00 50	3. 20 a. m.	59	69		906	Bu. m	NE.	6	SW.	3	Do.
	4	2077	41 09 40	66 02 20	8. 00 a. m.	57	68	39	1, 255	Bu. m	NW.	2	NW.	5	Do.
	4	2078	41 11 30	66 12 20	1. 40 p. m.	60	66	40	499	Gy. m. and s	NW.	2	W.	2	Do.
	4	2079	41 13 00	66 19 50	4. 15 p. m.	60	67½	45	75	Wh. s	NW.	2	W.	1. 5	Do.
	4	2080	41 13 00	66 21 50	5. 10 p. m.	60	67½	46	55	Gy. s	WSW.	2	WSW.	1. 5	Do.
	4	2081	41 10 20	66 30 20	6. 50 p. m.	59	56	46	50	Wh. s., blk. sp	SW.	1	NW. by W.	1	Do.
	4	2082	41 09 50	66 31 50	7. 41 p. m.	58	55	46½	49	Crs. yl. s	SW.	1	NW. by W.	1	Do.
	5	2083	40 26 40	67 05 15	4. 30 a. m.	73	72	40	959	Gy. m	SW.	2	SSW.	2. 5	Do.
	5	2084	40 16 50	67 05 15	9. 09 a. m.	73	78½	40	1, 290	Bu. m. and s	SW.	3	SSW.	4. 0	Do.
	20	2085	40 05 00	70 34 45	6. 56 a. m.	67	68	50	70	Bu. m	E.	3	N. by E.	1. 5	Do.
	20	2086	40 05 05	70 35 00	9. 20 a. m.	70	67	52½	69	Bu. m., gy. s	E.	3	NE. ½ E.	1. 5	Do.
	20	2087	40 06 50	70 34 15	10. 30 a. m.	71	67	50	65	Gn. m., wh. s	E.	3	NNE.	2	Do.
	20	2088	39 59 15	70 36 30	12. 40 p. m.	68	68	48	143	Yl. s	NE. by E.	3	S. by W.	1. 5	Do.
	20	2089	39 58 50	70 39 40	3. 13 p. m.	76	69	45	168	Gy. s	E.	3	N.	1. 5	Do.
	20	2090	39 59 40	70 41 10	4. 40 p. m.	71	68	48½	140	Gy. s., brk. sh	ENE.	3	NE.	1. 5	Do.
	21	2091	40 01 50	70 59 00	5. 30 a. m.	68	69	49	117	Gn. m.	E.	3	N.	2. 5	Do.
	21	2092	39 58 35	71 00 30	7. 50 a. m.	74	67½	45	197	Gn. m	E.	3	NE.	2. 5	Do.
	21	2093	39 42 50	71 01 20	1. 12 p. m.	75	69	39	1, 000	Foraminifera, s., m	E.	3	N. by W.	5	Do.
	21	2094	39 44 30	71 04 00	5. 07 p. m.	70	68	38½	1, 022	Foraminifera, s., m	NE.	5	NNE.	5	Do.
	30	2095	39 29 00	70 58 40	9. 02 a. m.	71½	69½		1, 342	Glob. oz	SSW.	3	S.	2	Do.
	30	2096	39 22 20	70 52 20	2. 07 p. m.	70	69	37½	1, 451	Glob. oz	SSW.	2	SW.	1. 5	Do.
Oct.	1	2097	37 56 20	70 57 30	5. 30 a. m.	73	72½		1, 917	Glob. oz	SW.	3	S. ½ W.	1. 5	Do.
	1	2098	37 40 30	70 37 30	1. 08 p. m.	73	72½		2, 221	Glob. oz	NW.	4	W. by S.	2	Do.
	2	2099	37 12 20	69 39 60	5. 30 a. m.	71	82		2, 949	Glob. oz	SE.	6	SSW.	2	Do.
	3	2100	39 22 60	68 34 30	11. 05 a. m.	63	69	37½	1, 628	Glob. oz	WNW.	3	E.	2	Do.
	3	2101	39 18 30	68 24 00	4. 31 p. m.	61	67	37	1, 686	Glob. oz	WSW.	3	S.	2	Do.
Nov.	5	2102	38 44 00	72 38 00	6. 53 a. m.	64	62½	39	1, 209	Glob. oz	Var.	0–1	SSW.	1. 7	Do.
	5	2103	38 47 20	72 37 00	11. 14 a. m.	67	62	39	1, 091	Glob. oz	SSW.	1	SSE.	1. 5	Do.
	5	2104	38 48 00	72 40 30	3. 41 p. m.	67	63	41½	991	Bu. m	SSE.	2	S.	0. 5	Do.
	6	2105	37 50 00	73 03 50	6. 06 a. m.	63	63	41	1, 395	Glob. oz	SW.	3	S. by W.	3	Do.
	6	2106	37 41 20	73 03 20	Meridian.	66	63	42½	1, 497	Glob. oz	SSW.	3	S. by W.	3	Do.
	9	2107	35 19 30	75 15 20	8. 23 a. m.	71	76		16½	Fne. dk. gy. s., small sh.	W.	3	S.	0. 5	Do.
	9	2108	35 16 00	75 02 30	11. 00 a. m.	76	78½	66	48	Bu. m., crs. s	SSW.	4	S. by W.	0. 5	Do.
	9	2109	35 14 20	74 59 10	1. 03 p. m.	74	76	50½	142	Bu. m	SSW.	4	S.	1	Do.
	9	2110	35 12 10	74 57 15	2. 50 p. m.	76	75½	40	516	Bu. m	SSW.	4	S. by W.	0. 8	Do.
	9	2111	35 09 50	74 57 40	5. 25 p. m.	75	76		938	Gn. m	SW.	4	S.	1. 5	Do.
	10	2112	35 20 50	75 18 00	9. 15 a. m.	70	70	73½	15½	S., blk. sp	SW.	4	SW.	0. 8	Do.
	10	2113	35 20 30	75 19 00	10. 04 a. m.	72	70	72½	15	M., blk. s	SW.	4	SW.	1	Do.
	10	2114	35 20 00	75 20 00	11. 15 a. m.	73	70	72	14	M., blk. s	SW.	4	SW. by S.	0. 8	Do.
	11	2115	35 49 30	74 34 45	7. 54 a. m.	77	78	39	843	M., fne. s	SW.	4	S. by W.	1. 5	Do.
	11	2116	35 45 23	74 31 25	Meridian.	76	77	39	888	Bu. m., fne. s	WSW.	4	S.	1. 5	Do

II.—*Serial temperatures, U. S. Fish Commission steamer Albatross, Lieutenant-Commander Z. L. Tanner, U. S. N., commanding, 1883.*

Date.	Locality. Latitude north.	Locality. Longitude west.	Depth.	Air.	Surface.	5 fathoms.	10 fathoms.	15 fathoms.	20 fathoms.	25 fathoms.	40 fathoms.	60 fathoms.	100 fathoms.	200 fathoms.	300 fathoms.	400 fathoms.	500 fathoms.	600 fathoms.	700 fathoms.	800 fathoms.	900 fathoms.	1,000 fathoms.	1,100 fathoms.	1,200 fathoms.	1,300 fathoms.	1,400 fathoms.	1,500 fathoms.	1,600 fathoms.	Bottom.
1883.	° ′ ″	° ′ ″	Fathoms.																										
Apr. 27	35 09 40	75 04 36	92	67	72	75	75	74																					74½
27	35 09 58	74 59 18	69	76	76	76	76	76	76		76	69																	
28	35 29 35	74 46 45	531	64	69	69	71	70½	69		65	59																	
28	35 31 00	74 45 30	724	66	62									42½	40½	40													
28	35 30 00	74 44 45	890	65	61	61	69	70	69																				
30	36 46 15	74 27 50	670	79	46	45	44	42	42		45	43	52		41		39½	39	39										
May 5	37 31 00	74 52 36	19	48½	47	45½	45½	45½																					45½
5	37 29 40	74 53 00	17	49	47	46½	45½	45½																					45½
7	37 12 22	74 20 04	788	62	54	52¼	51¾	52½	53		52	50	50¾																39
7	37 13 52	74 23 52	600	56½	52¼	51¼	51¼	51½	51½		52	52½																	39
21	37 37 50	74 15 30	143	56	54				52½																				
21	37 36 00	74 15 00	179	58	54	52½	53	57	54		51½																		45
21	37 32 00	74 13 20	487	59	52	52½	52	52	52½		53½	53																	40
21	37 48 00	74 01 30	377	62	56	55	55	54½	55		54	54	54																
25	40 02 00	70 27 00	239	57	49	48½	48	46	44½		42½	42½	48½																40½
25	39 58 25	70 37 00	198	56	52								48																43
25	39 57 50	70 32 00	209	56	52						49																		41
25	39 42 00	70 47 00	1,168	57	53	52	52	52	51		50½	50½	50	46¼	40½	40	39½												38½
26	39 29 00	72 19 40	74	55	50	49	48½	43	39½		46½	43½																	47½
26	39 32 30	72 18 35	379	62	49½	49	48½	46½	43½		39½	40½	50	42	41½														41
July 17	39 26 16	70 02 37	1,362	73	71	71	69½	52½	48	44	46		44½	41	40½	39½	40	40	39½	40	39	40							
18	38 52 40	69 24 40	1,735	82	76	74	72	68	65	62½	60					48	48	40	39½		38½		38½	40½	40½	38½		38	38
18	38 53 00	69 23 30	1,731	79	76	74	73	66	63	62	61																		38
26	38 30 30	69 08 25	2,033	77	76½	77	77	71	66	62½	58																		
27	37 58 30	69 01 20	2,451	78	82					72			53			54													36½
28	38 19 26	68 20 20	2,369	77½	81	81	81	81	81	77	68	60	50½	55	43	40½		40	39	39	39	39							
29	38 35 13	68 16 00	2,226	76	76	75½	75½	76	75½	68	56½																		
30	39 33 00	68 26 45	1,555	74	71		71½				57½																		
31	40 01 50	68 50 30	608	72	72	70	68	55	65	58	44	43½	45	43½	40	40													40
Aug. 30	41 58 00	67 57 45	43	58	58½	58	57	57	56	56																			50
31	42 23 00	66 23 00	141	60	57½	57½																							46
31	42 23 30	66 21 15	115	57	54	53	53	53	49½	53	51½	44	42½																42½
Sept. 1	41 55 30	65 47 10	113	61	57		55	54½	53																				42½
1	41 56 40	65 50 10	102	58	55	55	55	55	54	52½	53	41½																	43
2	41 53 00	65 35 00	858	70	56	56																							39
3	41 40 30	65 35 00	855	58	58			59	54½	48½																			39
4	41 13 00	66 19 50	75	60	67½	67½																							45
20	40 06 50	70 34 15	65	71	67	58																							50
20	40 01 50	70 39 20	111	70	68	68	68	69½	69½	61	47	52																	49

	21	39	42	50	71	01	20	1,000	75	69	68	68	68																					39
	21	39	44	30	71	04	00	1,022	70	68	68	67½	67½	67	47½	51	52½																	38½
	30	39	29	00	70	58	40	1,342	71½	69½	67																							
	30	39	22	20	70	52	20	1,451	70	69	67½	68	68	67	66	56½	65½	53½	47	40½	40	40	39½	39½	38½	39	38½							37½
Oct.	1	37	56	20	70	57	30	1,917	73	72½	68																							
	1	37	40	30	70	37	30	2,221	73	72½	72																							
	2	37	12	20	69	39	00	2,949	71	82																								
	3	39	18	30	68	24	00	1,686	61	67	69	68																						37
Nov.	5	38	44	00	72	38	00	1,209	64	62½	62	61½	61½																					39
	5	38	48	00	72	40	30	991	60	61	62	62	62	62	62	59	55	53½	43½	40½	40	40	39½	39		39								41½
	6	37	34	48	73	03	15	1,542	62	62	62	62	62	62	62½	54	39½	51½	43½	41	39½	39½	39	39	39	38½								37
	9	35	16	00	75	02	30	48	76	78½	77	78	78	77	75	68½																		66
	9	35	16	20	75	04	00	34	75	77																								74
	9	35	14	30	75	00	30	102	74	76																								52
	11	35	44	30	74	28	45	1,066	76	76½	77	77	77	77	77	68½	69	40	45	41	40	40	39											
	12	36	16	15	74	51	20	40	65	68																								56

III.—*Specific gravities of sea-water, U. S. Fish Commission steamer Albatross, by Passed Assistant Surgeon C. G. Herndon, U. S. N.*, 1883.

Date.	Station.	Depth of the sea.	Depth at which the water was taken.	Temperatures at these depths.	Temperature.	Specific gravity.	Corrected to 60° F.
		Fathoms.	*Fathoms.*	°	°		
July 17, 1883	2034	1,280	Surface.	71	64	1.026	1.026548
Do	2034		100	44	62	1.0265	1.026770
Do	2034		200	41	61	1.0265	1.026630
Do	2034		300	40.5	61	1.027	1.027130
Do	2034		400	39.5	61	1.027	1.027130
Do	2034		500	40	61	1.0275	1.027630
Do	2034		600	40	61	1.0275	1.027630
Do	2034		700	39.5	61	1.0275	1.027630
Do	2034		800	40	60	1.028	1.028000
Do	2034		900	39	60	1.0285	1.028500
Do	2034		1,000	39.75	60	1.030	1.030000
Do	2035		Surface.	73	65	1.026	1.026690
Do	2035		5	71	65	1.026	1.026690
Do	2035		10	69.5	62	1.0265	1.026770
Do	2035		15	52.5	60	1.027	1.027000
Do	2035		20	48	60	1.027	1.027000
Do	2035		25	50	60	1.027	1.027000
Do	2035		40	46	60	1.027	1.027000
July 18, 1883	2036	1,735	Surface.	75	75	1.026	1.028265
Do	2036		5	74	75	1.026	1.028265
Do	2036		10	72	73	1.0265	1.028424
Do	2036		15	68	71	1.027	1.028606
Do	2036		20	65	70	1.027	1.028445
Do	2036		25	60	65	1.027	1.027696
Do	2036		40	60	65	1.028	1.028690
Do	2036		600	39.75	60	1.028	1.028000
Do	2036		700	39.5	60	1.028	1.028000
Do	2036		800	39	60	1.028	1.028000
Do	2036		900	38.5	60	1.028	1.028000
Do	2036		1,000	38.5	60	1.028	1.028000
Do	2036		1,100	38.5	60	1.028	1.028000
Do	2036		1,200	40.5	60	1.029	1.029000
Do	2037	1,731	Surface.	76	76	1.026	1.028432
Do	2037		5	74	76	1.026	1.028432
Do	2037		10	73	75	1.027	1.028265
Do	2037		15	66	70	1.027	1.027145
Do	2037		20	63	68	1.027	1.028136
Do	2037		25	62	66	1.027	1.027840
Do	2037		40	61	65	1.028	1.028690

IV.—*Temperature and density of sea-water from August* 31 *to November* 11, 1883.—*U. S. Fish Commission steamer Albatross.*

Date.	Station.	Depth.	Temperature by attached thermometer.*	Temperature of the air.	Temperature at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
			°	°	°		
August 31, 1883	2064	Surface.	54	58	82	1.0218	1.025320
Do	2064	5	53	58	81	1.0222	1.025539
Do	2064	10	53	58	81	1.0222	1.025539
Do	2064	15	53	58	81	1.0222	1.025539
Do	2064	20	49.5	58	81	1.0222	1.025539
Do	2064	25	53	58	81	1.0222	1.025539
Do	2064	40	51.5	58	81	1.0224	1.025739
Do	2064	60	44	58	81	1.0225	1.025839
Do	2064	100	42.5	58	80	1.0232	1.026360
September 1, 1883	2071	Surface.	55	58	82	1.0220	1.025520
Do	2071	5	55	58	81	1.0220	1.025339
Do	2071	10	55	58	81	1.0220	1.025339
Do	2071	15	55	58	81	1.0220	1.025339

IV.—*Temperature and density of sea-water, &c.*—Continued.

Date.	Station.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
			°	°	°		
September 1, 1883	2071	20	54	58	81	1.0224	1.025739
Do	2071	25	52.5	58	81	1.0224	1.025739
Do	2071	40	53	58	81	1.0224	1.025739
Do	2071	60	41.5	58	81	1.0226	1.025939
Do	2071	100	43	58	81	1.0226	1.025939
September 20, 1883, 11 a. m	2087	Surface.	69	71	70	1.0252	1.026650
September 20, 1883	2087	5	68	71	70	1.0252	1.026650
September 20, 1883, 2 p. m	2088	Surface.	69	70	70	1.0252	1.026650
September 20, 1883	2088	5	68	70	70	1.0252	1.026650
September 20, 1883, 6 p. m	2090	Surface.	69	67	70	1.0251	1.026550
September 20, 1883	2090	5	68	67	70	1.0251	1.026550
September 21, 1883, 10 a. m	2092	Surface.	69	70	70	1.0253	1.026750
September 21, 1883	2092	5	68.25	70	71	1.0252	1.026806
September 21, 1883, 4 p. m	2093	Surface.	69	70	70	1.0250	1.026450
September 21, 1883	2093	5	68	70	70	1.0250	1.026450
September 21, 1883, 9 p. m	2094	Surface.	69	66	77	1.0240	1.026618
September 21, 1883	2094	5	65	66	75	1.0242	1.026465
September 30, 1883, 12 m	2095	Surface.	69	71	71	1.0251	1.026706
September 30, 1883	2095	5	67	71	71	1.0251	1.026706
September 30, 1883, 6 p. m	2096	Surface.	70	70	72	1.0251	1.026864
Do	2096	5	67.5	70	72	1.0251	1.026864
Do	2096	10	68	70	72	1.0251	1.026864
Do	2096	15	68	70	72	1.0252	1.026964
Do	2096	20	67	70	71	1.0253	1.026906
Do	2096	25	66	70	67	1.0257	1.026687
Do	2096	40	57.5	70	67	1.0264	1.027387
Do	2096	60	55.5	70	67	1.0266	1.027587
Do	2096	100	55.5	70	84	1.0236	1.027512
Do	2096	200	47	70	85	1.0235	1.027600
Do	2096	300	40.5	70	85	1.0235	1.027600
Do	2096	400	40	70	85	1.0235	1.027600
Do	2096	500	40	70	85	1.0235	1.027600
Do	2096	600	39.5	70	86	1.0233	1.027616
Do	2096	700	39.5	70	85	1.0235	1.027600
Do	2096	800	38.5	70	85	1.0236	1.027700
Do	2096	900	39	70	86	1.0235	1.027816
Do	2096	1,000	38.5	70	86	1.0235	1.027816
October 1, 1883, 10 a. m	2097	Surface.	69	73	75	1.0253	1.027565
Do	2097	5	68	73	75	1.0253	1.027565
October 2, 1883, 10 a. m	2098	Surface.	74	77	76	1.0248	1.027232
Do	2098	5	72	77	76	1.0248	1.027232
October 3, 1883, 10 a. m	2101	Surface.	68	72	75	1.0246	1.026865
Do	2101	5	73	72	69	1.0248	1.026724
November 5, 1883, 11 a. m	2102	Surface.	63	64	64	1.0266	1.027148
November 5, 1883, 3 p. m	2103	Surface.	64	67	65	1.0264	1.027090
November 5, 1883, 7 p. m	2104	Surface.	63	62	64	1.0266	1.027148
Do	2104	5	62	62	63	1.0264	1.026811
Do	2104	10	62	62	63	1.0264	1.026811
Do	2104	15	62	62	65	1.0262	1.026890
Do	2104	20	62	62	63	1.0263	1.026711
Do	2104	25	62	62	63	1.0266	1.027011
Do	2104	40	59	62	64	1.0264	1.026948
Do	2104	60	55	62	62	1.0270	1.027270
Do	2104	100	53.5	62	59	1.0276	1.027480
Do	2104	200	43.5	62	57	1.0274	1.027040
Do	2104	300	40.5	62	57	1.0274	1.027040
Do	2104	400	40	62	57	1.0274	1.027040
Do	2104	500	40	62	56	1.0273	1.026820
Do	2104	600	39.5	62	57	1.0273	1.026940
Do	2104	700	39	62	57	1.0272	1.026840
Do	2104	800	---	62	57	1.0273	1.026940
Do	2104	900	39	62	57	1.0273	1.026940
November 6, 1883, 11 a. m	2105	Surface.	62	67	65	[illegible]	[illegible]
November 6, 1883, 6 p. m	2106	Surface.	62	62	66	[illegible]	[illegible]
Do	2106	5	62	62	64	[illegible]	[illegible]
Do	2106	10	62	62	65	[illegible]	[illegible]
Do	2106	15	62	62	64	1.0263	[illegible]
Do	2106	20	62	62	64	1.0263	[illegible]
Do	2106	25	62.5	62	64	[illegible]	[illegible]
Do	2106	40	54	62	63	1.0265	[illegible]
Do	2106	60	49.5	62	60	1.0267	[illegible]
Do	2106	100	51.5	62	60	1.0270	1.027000

IV.—*Temperature and density of sea-water, &c.*—Continued.

Date.	Station.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
			°	°	°		
November 6, 1883, 6 p. m	2106	200	43.5	62	58	1.0272	1.026960
Do	2106	300	41	62	58	1.0272	1.026960
Do	2106	400	39.5	62	58	1.0272	1.026960
Do	2106	500	39.5	62	58	1.0272	1.026960
Do	2106	600	39	62	58	1.0274	1.027160
Do	2106	700	39	62	58	1.0274	1.027160
Do	2106	800	39	62	58	1.0274	1.027160
Do	2106	900	38.5	62	58	1.0274	1.027160
Do	2106	1,000	37	62	57	1.0275	1.027140
November 9, 1883, 10 a. m	2107	Surface.	62	76	79	1.0250	1.027983
November 9, 1883, 12.30 p. m	2108	Surface.	78	74	78	1.0252	1.028008
November 9, 1883, 2 p. m	2109	Surface.	76	75	78	1.0252	1.028008
November 9, 1883, 5 p. m	2110	Surface.	76	75	77	1.0254	1.028018
November 9, 1883, 10 p. m	2111	Surface.	76	76	77	1.0253	1.027918
November 10, 1883, 12 m	2114	Surface.	71	74	73	1.0250	1.026924
November 11, 1883, 11 a. m	2115	Surface.	78	74	78	1.0252	1.028008
November 11, 1883, 5 p. m	2116	Surface.	78	75	74	1.0256	1.027686
Do	2116	5	77	75	74	1.0256	1.027686
Do	2116	10	77	75	75	1.0255	1.027765
Do	2116	15	77	75	75	1.0255	1.027765
Do	2116	20	77	75	75	1.0255	1.027765
Do	2116	25	77	75	75	1.0255	1.027765
Do	2116	40	68.5	75	75	1.0255	1.027765
Do	2116	60	69	75	75	1.0256	1.027865
Do	2116	100	40	75	75	1.0256	1.027865
Do	2116	200	45	75	73	1.0254	1.027324
Do	2116	300	41	75	74	1.0249	1.026986
Do	2116	400	40	75	75	1.0250	1.027265
Do	2116	500	40	75	75	1.0252	1.027465
Do	2116	600	39	75	75	1.0252	1.027465

V.—*Meteorological record on board the U. S. Fish Commission steamer Albatross, from April 24 to May 27, and from September 29 to October 4, 1883.*

Date.	Barometer.		Air.				Surface water.		State of sea.	Wind.		State of weather.
			Dry bulb.		Wet bulb.							
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.		Direction.	Force.	
			°	°	°	°	°	°				
April 24, 1883	30.14	29.88	44	40	44	40	......	......	Smooth	Variable	0–3	Overcast and rainy.
April 25, 1883	30.28	30.16	51	38	52	38	52	49	Smooth	NW. and SSE	1–5	Clear and pleasant.
April 26, 1883	30.44	30.24	68	46	61	45	53	49	Smooth	SW. to ENE	0–2	Do.
April 27, 1883	30.22	30.04	70	52	65	52	75	49	Smooth	W. and SSW	0–2	First part clear, second part overcast.
April 28, 1883	30.04	29.90	68	55	65	55	70	51	Smooth	SW. to W	0–3	Clear, hazy about horizon.
April 29, 1883	30.08	29.82	64	44	63	44	57	46	Smooth, then moderate	S. and NNE	1–7	Clear during forenoon, then overcast and rainy.
April 30, 1883	30.42	30.08	80	45	73	44	48	45	Moderate	NNE. to ENE	1 to 6	Clear and pleasant.
May 1, 1883	30.42	30.30	54	47	53	46	51	46	Smooth	NNE. to ENE	1 to 3	Passing clouds.
May 2, 1883	30.26	30.14	52	47	52	48	51	45	Moderate	NE	1–6	Cloudy.
May 3, 1883	30.19	30.11	48	46	48	46	50	45	Moderate, then rough, then long swell.	NNW. to E	1–6	Cloudy and foggy.
May 4, 1883	30.24	30.16	63	45	55	45	50	45	Smooth	E. and SSE	1–2	Do.
May 5, 1883	30.26	30.16	63	49	62	40	50	46	Moderate	ENE. to N	1–6	Do.
May 6, 1883	30.24	30.14	68	49	65	49	65	47	Long swell	WNW. to ENE	1–3	Foggy at first, afterwards clearing.
May 7, 1883	30.30	30.18	61	50	58	50	58	48	Long swell	Var. and SW. to S	0–3	Clear and pleasant.
May 8, 1883	30.16	30.08	71	53	68	52	62	48	Smooth	South	1–3	Do.
May 9, 1883	30.22	30.10	96	67	89	65	73	62	Smooth	S. to SW	1–2	Do.
May 10, 1883	30.30	30.10	86	66	84	65	73	64	Smooth	SW. to SE	1–3	Do.
May 11, 1883	30.16	30.08	76	66	76	66	71	68	Smooth	SSW. to WSW	0–3	Clear; passing clouds.
May 12, 1883	30.16	30.10	87	56	82	56	69	65	Smooth	NW. to NE	0–2	Clear and pleasant.
May 13, 1883	30.20	30.08	83	56	75	54	70	66	Smooth	N. by E	0–1	Do.
May 14, 1883	30.20	29.90	78	56	74	56	70	65	Smooth	E. to SW	0–4	Passing clouds.
May 15, 1883	29.86	29.60	85	65	77	62	73	69	Smooth	S. to NW	1–3	Do.
May 16, 1883	30.18	29.84	95	54	82	53	68	61	Smooth	NW. to NNE	1–3	Clear and pleasant.
May 17, 1883	30.38	30.18	76	49	69	49	68	60	Smooth	N. to NE	1–2	Do
May 18, 1883	30.42	30.32	83	46	73	46	71	53	Smooth	NW. to E. by N	0–2	Do.
May 19, 1883	30.30	30.00	57	53	54	50	57	48	Rough	NE	2–6	Do.
May 20, 1883	29.98	29.76	57	51	57	53	56	50	Moderate, long swell	NNW	1–2	Cloudy and foggy.
May 21, 1883	29.72	29.58	59	55	63	55	61	48	Long swell	SE	1–3	Overcast and foggy.
May 22, 1883	29.70	29.54	64	55	62	52	56	50	Moderate, long swell	SE	2–4	Passing clouds and foggy.
May 23, 1883	29.82	29.71	61	50	60	50	62	48	Long swell	ENE. to SSW	2–4	Do.
May 24, 1883	30.08	29.82	63	51	60	50	53	49	Smooth	WSW. to SW	2–5	Clear and pleasant.
May 25, 1883	30.24	30.08	58	49	58	49	53	46	Smooth	NNW. to SW	1–3	Do
May 26, 1883	30.18	29.92	68	51	62	51	52	49	Smooth	SW. to SSW	3–4	Do.

V.—*Meteorological record on board the U. S. Fish Commission steamer Albatross, &c.*—Continued.

Date.	Barometer.		Air.				Surface water.		State of sea.	Wind.		State of weather.
			Dry bulb.		Wet bulb.							
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.		Direction.	Force.	
			°	°	°	°	°	°				
May 27, 1883	29.88	29.78	75	55	75	55	65	51	Smooth	SW. to S.	1–5	Overcast, gradually clearing.
September 29, 1883	30.32	30.18	71	56	69	56	64	57	Smooth	E. to NW. to S	1–3	Passing clouds.
September 30, 1883	30.18	29.92	72	64	72	64	70	60	Smooth	S. to SSW	2–4	Do.
October 1, 1883	30.06	29.86	80	66	78	65	75	71	Moderate	SSW. to NW. to NE	2–4	Do.
October 2, 1883	30.10	29.76	82	67	81	65	83	76	Rough	NE. to SE. to SW.	2–8	Passing clouds; squally.
October 3, 1883	30.12	29.76	78	61	77	57	82	67	Rough	NNW. to WNW.	3–7	Do.
October 4, 1883	30.36	30.12	64	45	62	43	66	55	Rough, then moderate	NNW. to WNW.	4–7	Clear and pleasant.

VI.—*Record of speed of 5 trawlings and soundings, July, 1883, U. S. Fish Commission steamer Albatross, Lieutenant-Commander Z. L. Tanner, U. S. N., commanding.*

TRAWL—GOING DOWN.

Fathoms.	Number of station.				
	2038.	2039.	2040.	2041.	2042.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Surface to 100	4 00	5 15	7 20	3 55	4 00
100 to 200	5 00	4 05	4 10	4 30	4 00
200 to 300	5 00	3 50	3 15	4 00	3 45
300 to 400	4 00	4 00	4 25	4 30	5 30
400 to 500	4 40	5 30	9 05	4 30	3 55
500 to 600	4 00	4 45	4 15	4 46	3 30
600 to 700	4 00	3 53	4 00	4 45	3 30
700 to 800	5 20	4 02	3 30	4 47	5 00
800 to 900	4 45	4 15	4 00	4 45	4 00
900 to 1,000	4 10	4 00	3 40	4 47	4 30
1,000 to 1,100	4 05	7 35	4 20	4 47	4 00
1,100 to 1,200	4 50	6 15	3 40	5 05	4 00
1,200 to 1,300	9 20	7 25	4 15	4 20	4 10
1,300 to 1,400	6 00	5 00	4 15	4 20	4 10
1,400 to 1,500	5 50	5 00	3 40	4 20	4 00
1,500 to 1,600	4 30	4 30	4 40	4 30	4 20
1,600 to 1,700	4 30	4 30	4 35	4 40	4 10
1,700 to 1,800	6 00	4 00	7 40	4 25	4 15
1,800 to 1,900	5 15	8 00	6 20	4 20	3 50
1,900 to 2,000	4 15	11 45	5 25	4 10	3 40
2,000 to 2,100	5 05	7 45	5 00	4 10	3 45
2,100 to 2,200	5 00	7 50	5 10	4 10	....
2,200 to 2,300	4 35	7 00	7 00	*2 00	....
2,300 to 2,400	4 20	5 00	6 15	....	....
2,400 to 2,500	4 00	5 00	7 00	....	....
2,500 to 2,600	9 30	6 45	6 45	....	....
2,600 to 2,700	5 30	4 50	4 00	....	....
2,700 to 2,800	....	5 00	3 30	....	....
2,800 to 2,900	....	9 55	4 00	....	....
2,900 to 3,000	....	5 00	3 40	....	....
3,000 to 3,100	....	4 20	....	....	....
3,100 to 3,200	....	6 15	....	....	....
Total time	2 17 30	3 02 15	2 28 40	1 40 32	1 26 00
Average speed per 100 fathoms	5 05	5 42	4 57	4 28	4 06
Depth in fathoms	2,033	2,369	2,226	1,608	1,555

* To 2,250 fathoms.

TRAWL—COMING UP.

100 to surface	4 30	5 15	6 00	4 40	3 25
200 to 100	4 00	3 45	3 00	4 40	3 25
300 to 200	4 00	4 00	3 31	4 40	3 25
400 to 300	5 55	5 30	3 31	4 40	3 25
500 to 400	4 00	4 00	3 31	4 40	3 25
600 to 500	4 00	3 30	3 31	4 40	3 25
700 to 600	2 40	4 00	3 31	4 40	3 20
800 to 700	4 15	3 45	3 31	5 45	3 20
900 to 800	3 30	4 00	3 31	4 30	3 20
1,000 to 900	3 00	4 00	3 31	4 25	3 45
1,100 to 1,000	3 00	3 45	3 32	4 55	5 00
1,200 to 1,100	4 00	4 30	4 35	5 10	4 00
1,300 to 1,200	3 30	4 15	4 00	6 15	5 00
1,400 to 1,300	3 30	4 55	4 00	7 00	5 45
1,500 to 1,400	4 00	4 25	4 00	7 00	5 45
1,600 to 1,500	4 15	3 55	4 00	10 00	5 45
1,700 to 1,600	9 00	3 30	3 25	6 45	6 05
1,800 to 1,700	5 00	4 00	3 40	6 48	7 48
1,900 to 1,800	4 45	4 00	4 15	6 48	7 48
2,000 to 1,900	5 00	4 00	10 05	6 48	7 47
2,100 to 2,000	4 30	4 00	5 45	6 48	7 47
2,200 to 2,100	4 30	4 00	5 25	6 45	....
2,300 to 2,200	4 30	4 00	5 50	5 45	....
2,400 to 2,300	5 00	4 00	5 30	....	....
2,500 to 2,400	4 00	5 00	6 10	....	....
2,600 to 2,500	5 00	4 30	12 30	....	....
2,700 to 2,600	6 00	4 40	6 45	....	....
2,800 to 2,700	....	4 25	6 45	....	....
2,900 to 2,800	....	5 00	8 30	....	....

VI.—*Record of speed of* 5 *trawlings and soundings, July,* 1883, *&c.*—Continued.

TRAWL—COMING UP—Continued.

Fathoms.	Number of station.				
	2038.	2039.	2040	2041.	2042.
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
2,900 to 3,000	....	5 10	7 00	....	....
3,000 to 3,100	....	6 15	....	....	....
3,100 to 3,200	....	10 15	....	....	....
Total time	2 00 20	2 24 15	2 32 50	2 14 10	1 40 45
Trawl on bottom	1 14 30	1 47 30	2 37 20	1 51 25	1 26 50
Average speed per 100 fathoms	4 27	4 30	5 05	5 44	4 48

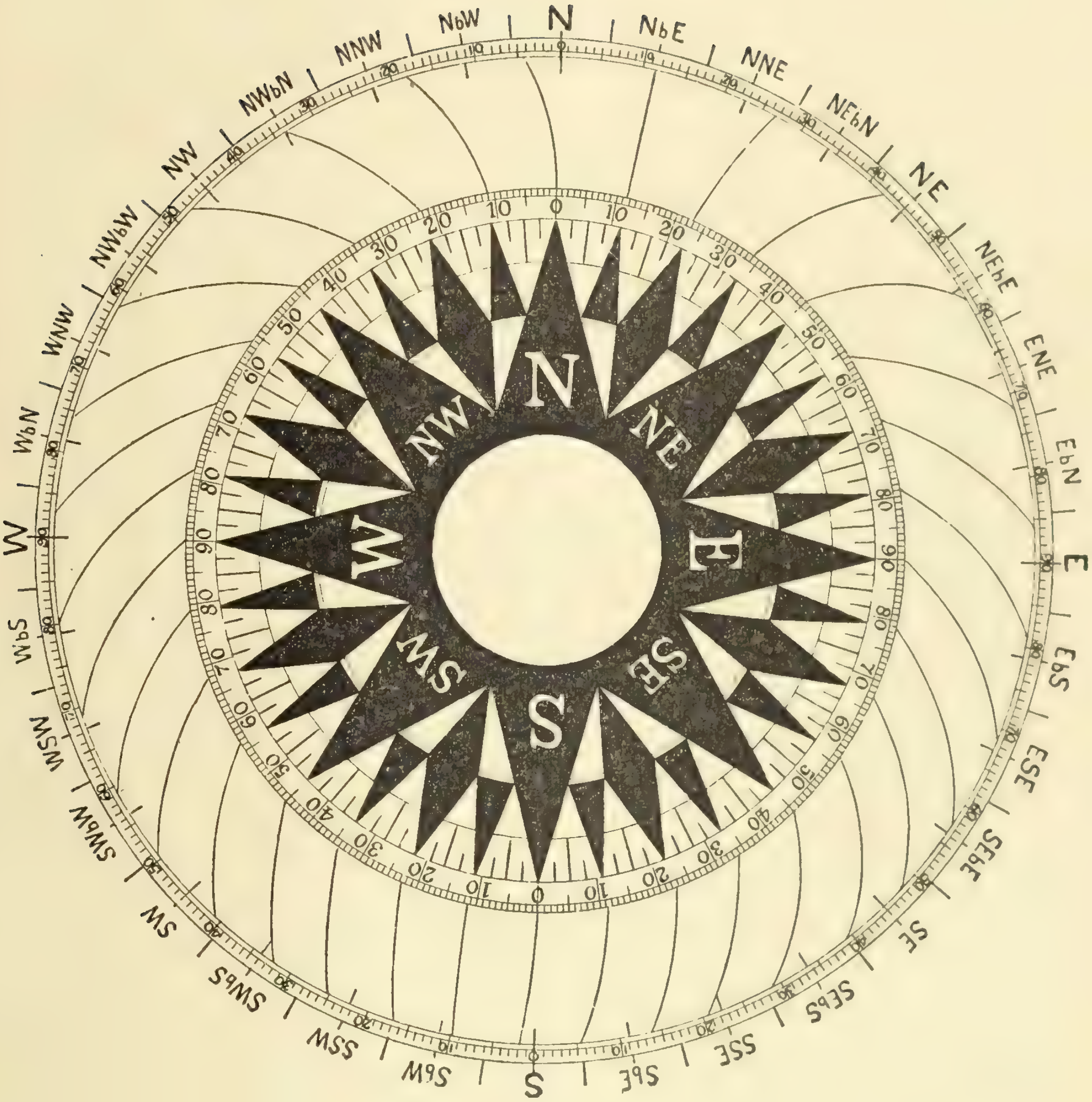
SOUNDING—GOING DOWN.

Fathoms.	2038.	2039.	2040	2041.	2042.
Surface to 100	1 02	0 57	1 30	1 20	1 00
100 to 200	0 56	0 55	1 30	1 20	0 55
200 to 300	0 57	1 00	1 30	1 20	4 00
300 to 400	1 00	0 46	1 30	1 20	6 30
400 to 500	1 02	0 58	1 30	1 20	1 25
500 to 600	1 02	1 02	1 30	1 15	1 03
600 to 700	1 07	1 00	1 30	1 25	1 17
700 to 800	1 09	1 02	1 30	1 18	1 15
800 to 900	1 08	1 00	1 30	1 22	1 25
900 to 1,000	1 16	1 07	1 30	1 17	1 20
1,000 to 1,100	1 14	1 06	1 30	1 23	1 25
1,100 to 1,200	1 17	1 04	1 30	1 21	1 25
1,200 to 1,300	1 07	1 08	1 30	1 19	1 30
1,300 to 1,400	1 17	1 10	1 30	1 20	1 25
1,400 to 1,500	1 16	1 11	1 30	1 20	*1 00
1,500 to 1,600	1 15	1 14	1 30	†0 24	....
1,600 to 1,700	1 22	1 05	1 00	....	....
1,700 to 1,800	1 28	1 12	1 45	....	....
1,800 to 1,900	2 40	1 18	1 20	....	....
1,900 to 2,000	‡3 33	1 15	1 30	....	....
2,000 to 2,100	....	1 15	1 20	....	....
2,100 to 2,200	....	1 20	§0 20	....	....
2,200 to 2,300	....	‖1 00	....	....	....
Total time	27 08	24 05	31 15	19 30	26 55
Average speed per 100 fathoms	1 21	1 01	1 21	1 13	1 43
Depth in fathoms	2,033	2,369	2,226	1,608	1,555

* To 1,480 turns.
† To 1,530 turns.
‡ To 1,942 turns.
§ To 2,125 turns.
‖ To 2,276 turns.

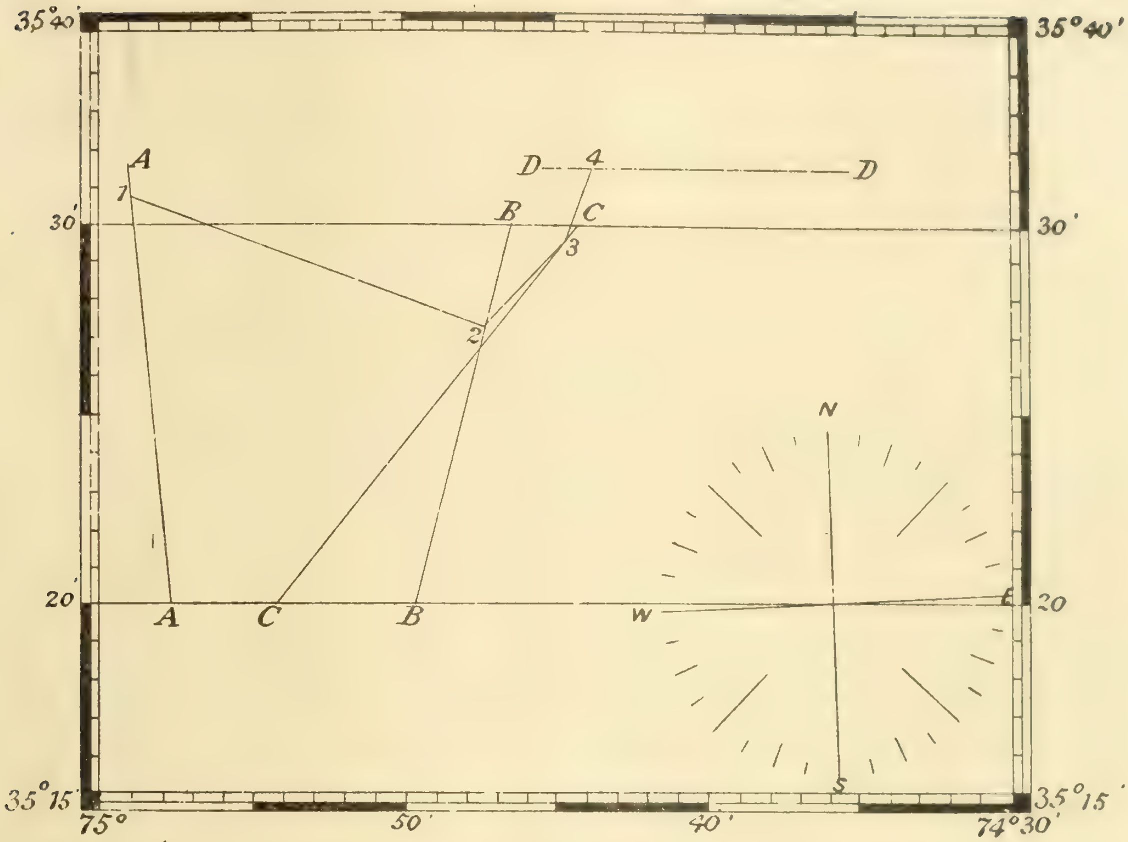
SOUNDING—COMING UP.

Fathoms.	2038.	2039.	2040	2041.	2042.
100 to surface	0 00	1 00	1 05	1 25	1 00
200 to 100	1 27	1 00	1 30	1 25	0 57
300 to 200	0 37	1 00	1 30	1 25	0 58
400 to 300	0 37	1 00	1 30	1 25	1 00
500 to 400	0 35	1 00	1 30	1 25	1 00
600 to 500	0 50	1 00	1 30	1 25	1 00
700 to 600	0 38	1 00	1 30	1 20	1 00
800 to 700	0 32	0 57	1 30	1 20	1 05
900 to 800	0 40	0 50	1 30	1 25	1 07
1,000 to 900	0 47	0 51	1 30	1 30	1 05
1,100 to 1,000	0 46	0 52	1 45	1 25	1 10
1,200 to 1,100	0 45	1 05	1 45	1 25	1 15
1,300 to 1,200	0 47	1 05	1 45	1 25	1 14
1,400 to 1,300	0 51	1 05	1 45	1 25	1 13
1,500 to 1,400	0 52	1 10	2 00	1 30	1 00
1,600 to 1,500	0 57	1 15	1 05	1 00	....
1,700 to 1,600	0 55	1 10	1 40	....	....
1,800 to 1,700	1 00	1 27	1 30	....	....
1,900 to 1,800	1 20	1 30	1 30	....	....
2,000 to 1,900	0 40	1 33	1 30	....	....
2,100 to 2,000	....	2 15	1 30	....	....
2,200 to 2,100	....	2 25	0 30	....	....
2,300 to 2,200	....	2 00	....	....	....
Total time	12 36	28 30	32 50	21 15	16 04
Average speed per 100 fathoms	0 36	1 12	1 28	1 19	1 02

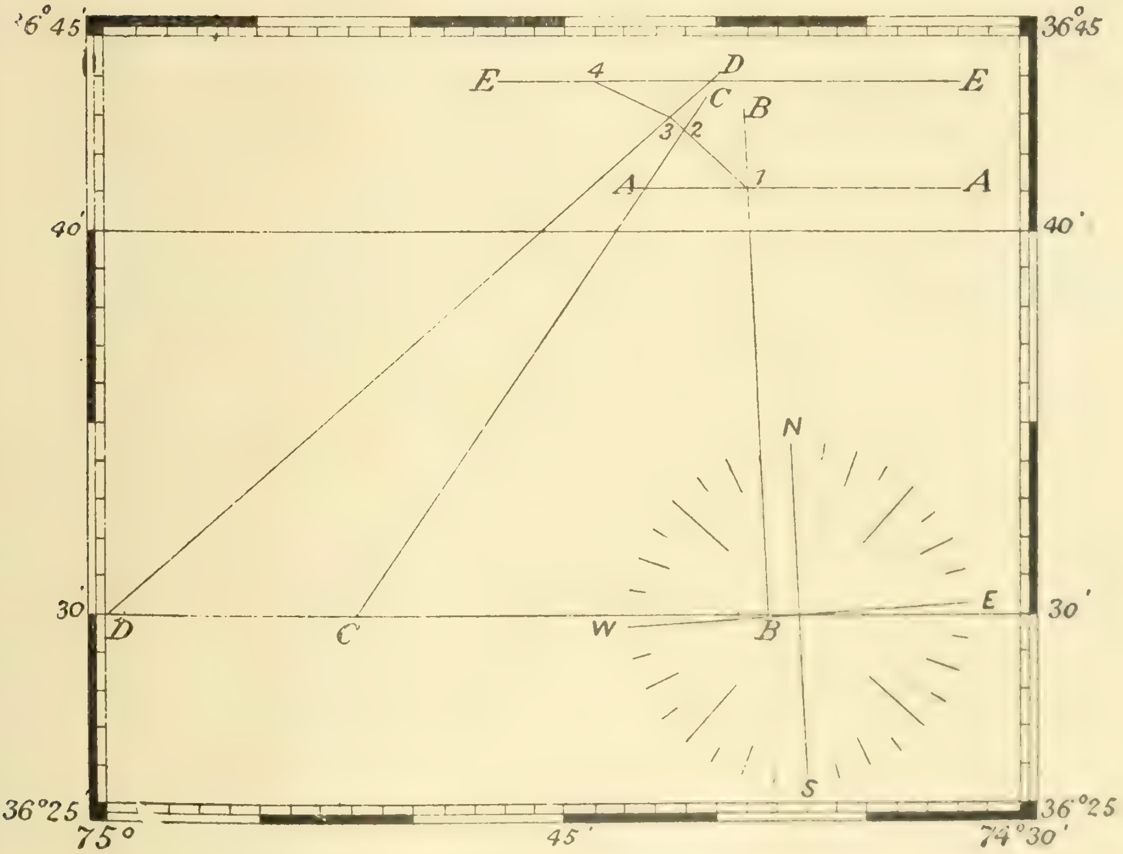


Steering card. Chesapeake Bay, April, 1883.

CASE I.

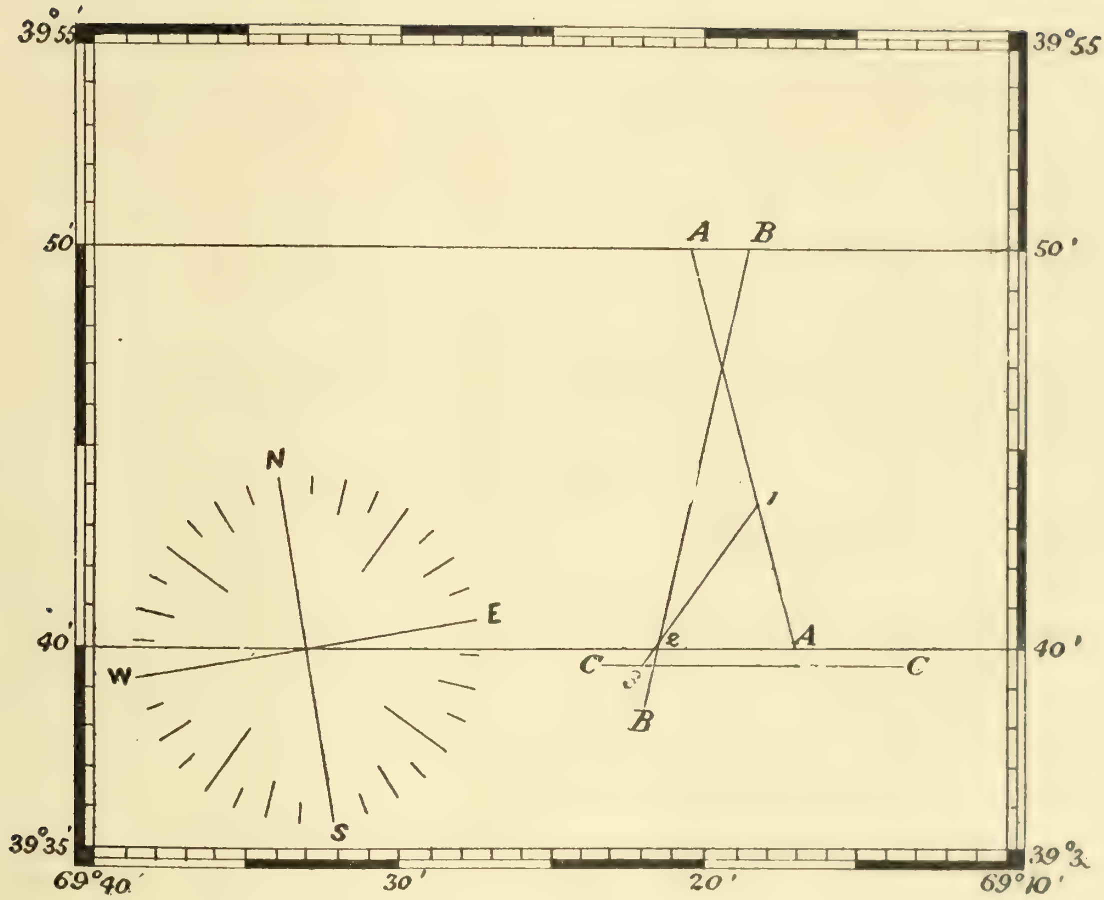


CASE II.



Illustrative cases in navigation.

CASE III.



Illustrative case in navigation.

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III.—EXPLORATIONS ON THE COLUMBIA RIVER FROM THE HEAD OF CLARKE'S FORK TO THE PACIFIC OCEAN, MADE IN THE SUMMER OF 1883, WITH REFERENCE TO THE SELECTION OF A SUITABLE PLACE FOR ESTABLISHING A SALMON-BREEDING STATION.

By LIVINGSTON STONE.

In the Territory of Montana, on the great Continental divide which separates the Atlantic slope of North America from the Pacific slope, and near where it is intersected by the forty-sixth parallel of latitude, is a very interesting spot. Here two tiny rivulets, close to each other at their source, set out on a long and widely diverging journey; one, flowing southward and taking a strangely circuitous course, becomes the Missouri River, and finally empties its waters into the Atlantic through the broad delta of the Mississippi, 4,000 miles from where it started; and the other, flowing northward, becomes at last the Columbia River, and enters the Pacific Ocean through an outlet 15 miles wide and fully 1,200 miles from its source. The latter rivulet, which is the one with which this report is concerned, although it is, correctly speaking, Clarke's Fork of the Columbia River, is not generally known by that name until it has become the river which is formed by the junction of the Flathead and Missoula. Looking now for the various sources which have formed this comparatively large river, we find that they all head in that part of the Bitter Root Mountains and the main range of of the Rockies which, roughly speaking, lie between the forty-fifth and forty-eighth parallels of latitude and receive the waters of all the numerous small streams which flow from the southwest slope of the Rocky Mountain range and the northwest slope of the Bitter Root range. Most of the streams rising in the Bitter Root Mountains flow into the Bitter Root River, while the streams rising in the Rocky Mountain range flow into the Big Blackfoot River and the Hellgate River, which latter stream is known a few miles above, and from there to where it heads in the mountains, as the Deer Lodge River. Just above Missoula, Mont., the Big Blackfoot River and the Hellgate River unite and flow together to Missoula, where they receive the waters of the Bitter Root River from the south. Below the junction of these streams, at Missoula, the river is known as the Missoula River, until it receives the waters of the Flathead River from the north, at the southeastern end of the Cœur d'Alêne range of mountains, below which junction it

is called the Clarke's Fork of the Columbia, although the whole course of the river known under the various names of Deer Lodge River, Hell-gate River, and Missoula River might be properly considered as Clarke's Fork of the Columbia, these being the original Clarke's Fork and forming one continuous stream as much as the Mississippi does from the Falls of Saint Anthony to Saint Louis. From the junction of the Flathead and Missoula the river flows for about 75 miles to Pend d'Oreille Lake through a magnificent wooded cañon which presents some of the finest scenery on the continent.

Pend d'Oreille Lake is really formed by the widening of the river, and is a large, beautiful sheet of water surrounded by picturesque mountains and navigable over its entire area. At the outlet of Lake Pend d'Oreille the river comes together again, taking here still another appellation, viz., Pend d'Oreille River, and flows smoothly and slowly for a distance variously estimated at from 15 to 30 miles, where it flows over a vertical fall 8 or 10 feet* in height and enters a mountainous cañon through which it rushes with such violence as to be wholly unnavigable, and, finally leaping over a fall of 15 feet in perpendicular height, it empties into the Columbia just north of the United States boundary, in about latitude 49° and longitude 117½°.

The Northern Pacific Railroad crosses the great Continental divide of the Rocky Mountain range just where the little streams and mountain torrents gather together to form the Deer Lodge River, which, as above stated, is the upper portion of Clarke's Fork under another name. After crossing the divide the railroad follows along down the valleys of the Deer Lodge, Hellgate, Missoula, and Clarke's Fork, and passing around the north side of the main body of Lake Pend d'Oreille, crosses the western arm of the lake, which finally narrows again into the river. Here the road permanently leaves the valley of Clarke's Fork nearly at right angles, and does not strike the Columbia River again till it reaches the mouth of Snake River, at Ainsworth, 336 miles from the ocean.

My instructions being to select a point for collecting salmon eggs which would be near the line of the Pacific Railroad, this precaution being necessary both for convenience in operating the station and for facility in distributing the eggs, it follows that any point above Pend d'Oreille Lake would be a perfectly satisfactory place for a collecting and distributing station, provided that a sufficient number of spawning salmon could be secured. This last most essential condition is wanting, however, along this whole line of river channel, for very few, if any, salmon ever reach Pend d'Oreille or the waters above it. This fact was a great surprise to the writer, but it is undeniable.

The testimony of all the persons consulted on the subject at Deer Lodge, Missoula, Sand Point, and at various smaller stations on the railroad was unanimous to the effect that no salmon were ever caught in Clarke's Fork or above. One man who was interrogated said that

* Dr. Suckley, in 1853, estimated the height of this fall at 6½ feet.

he had caught salmon in Lake Pend d'Oreille, but finally admitted that he had caught but one salmon, and the admission was made in such a way as to make the catching of the one salmon appear doubtful. At all events it is certain that no point on or above Lake Pend d'Oreille would furnish salmon enough for obtaining any considerable number of eggs.

The cause of the absence of salmon from a lake which flows directly into one of the greatest salmon rivers of the world is supposed by the local inhabitants to be the falls, mentioned above, which occur on the river about 15 miles below the outlet of the lake commonly known as the Falls of Seniakwoteen. I will add here that these falls are not properly called Seniakwoteen Falls, for the word means "a crossing," and, although there is a crossing a few miles below the mouth of the lake, the falls are much farther and are neither near nor in any way connected with the crossing or "Seniakwoteen" proper. The residents on the lake think that these falls prevent the salmon from coming up the river, but the writer thinks that it is quite as likely that the salmon are all or nearly all stopped by the falls at the mouth of the Pend d'Oreille River (Clarke's Fork) where it empties into the Columbia. A white ("squaw man") fur-trader lives at the crossing (Seniakwoteen), but I am informed that there is not another white settler along the whole course of the river from this point to its mouth. It is consequently very difficult to get any information concerning the run of salmon in the river, but the few persons that know anything about that region, who were consulted, could not remember having seen or heard of any salmon there, and the probability appears to be that very few, if any, salmon get past the falls at the mouth of Clarke's Fork and the intervening cascades between there and the falls below Lake Pend d'Oreille.

However this may be, the falls of Seniakwoteen (so-called) would not be a suitable place for a salmon-hatchery station, for three reasons:

1. It is too far from the railroad, being 30 or 40 miles by the nearest trail to a railroad station.

2. The region through which the railroad passes was one of the wildest portions of the United States till the railroad was built through it, and is now only very sparsely settled and very poorly furnished with supplies. The expense and inconvenience of building and carrying on a salmon-hatching station anywhere in this region would consequently be very great; so great, indeed, as to render the undertaking virtually impracticable.

3. The Indians on the Pend d'Oreille River, or, more properly speaking, the Pend d'Oreille "division" of Clarke's Fork, have always held undisputed possession of their wild and rugged cañon, and are extremely jealous of the intrusion of white men.

I am informed that they have driven out all white men who have come in there to settle, a *prima facie* evidence of which is found in the fact that there are no white settlers there at this day except the fur-trader just mentioned. I need not say that this would be a serious objection

to the establishment of a station there, as no one could tell what these high-spirited northern Indians might do at any moment in a remote and uninhabited place like the cañon of the Pend d'Oreille, provided they resented the advent of white men, as they undoubtedly would. I wish to say, by way of explanation, that I do not consider the country in question unsafe for white men to travel through, nor is there any likelihood of an outbreak by the native inhabitants along the river. I do not mean that either of these things is probable. What I mean to say is that, if a small body of white men should go into the cañon to stay and their presence should be objectionable to the savage residents of the country, they would probably find some means of getting rid of the obnoxious intruders.

Below the falls, near Seniakwoteen, to the mouth of Clarke's Fork, and from there on the Columbia to the mouth of Snake River, any place, however favorable on other accounts, would be out of the question as a collecting and distributing point for salmon eggs, on account of its distance from the railroad and its general inaccessibility. I will add that there is scarcely a white man to be found in that whole region of nearly 10,000 square miles, embraced between the Pend d'Oreille River on the north and east, the Columbia on the west, and the forty-eighth parallel on the south, except the very few settlers directly on the Columbia and Colville Rivers.

It might be thought that if a station was established on the Columbia, supplies could be brought up the river by steamer. This, however, could not be depended on at present, because from Priest Rapids to Grand Rapids, inclusive, the river is unnavigable at the following places, viz.: At Priest Rapids, 409 miles from the mouth of the Columbia; at Cabinet Rapids and Rock Island Rapids, 463 miles; at Foster Creek Rapids, Whirlpool Rapids, and Mahkin Rapids, 559 to 582 miles; at Spokane Rapids, 646 miles; and at Grand Rapids, 704 miles.

But as navigation could be opened through these rapids at a reasonable expense, and as this will probably be done sometime, because it would open up a navigable river distance of 302 miles to Kettle Falls, the time may come when it will be found desirable to establish a hatching station somewhere on the Columbia River between the mouth of Snake River and Kettle Falls, which latter place itself seems to present many conditions favorable to such an undertaking.

It was remarked above that the Northern Pacific Railroad leaves the valley of Clarke's Fork quite abruptly just below Lake Pend d'Oreille From here it pursues a general southwesterly course, crossing the great plain of the Columbia and not reaching the river again till it gets to Ainsworth, a railroad station on the Columbia at the mouth of the Snake River. On its way, however, it crosses an important river. This river is the Spokane, a stream flowing out of Cœur d'Alêne Lake and emptying into the Columbia 309 miles above the mouth of Snake River and 645 miles from the ocean. The Spokane has always been

famous as a great salmon river. Dr. Suckley often mentions it in that connection, and ever since the country has been opened up by white men it has been known that the Indians from all quarters assemble in the fall on this river and at the mouth of the Little Spokane, 8 miles to the northwest, to get their winter's stock of salmon. When I arrived at Spokane Falls, which is the point at which the railroad touches the Spokane River, and which is 70 miles from its mouth, I heard that Indians were fishing for salmon at the mouth of the Little Spokane, 8 miles distant. On driving over to the Little Spokane we found a large camp of Indians there, several of whom were industriously engaged in putting a salmon trap across the river. These traps consist of a dam of poles firmly bound together by withes and extending entirely across the river, with holes or traps at intervals into which the salmon can enter, but from which they cannot return. Having brought an interpreter with us we soon learned from the Indians that great numbers of spawning salmon came up to the mouth of the Little Spokane about the 1st of September. It was impossible to learn from the Indians how many salmon could be caught there in the spawning season, owing, I presume, to a trait which I have often observed among Indians, viz., an inability to fix with any precision upon exact numbers. For instance, when the interpreter asked the Indian he was talking with if twenty-five was the number that they caught in a day, the Indian answered yes; and when he asked him if they caught a hundred a day, he also said yes; and his other replies in regard to the numbers of the salmon caught were of the same character. However, the general impression left on our minds was that a great many salmon were caught here during the entire spawning season, possibly enough to warrant the establishing of a hatching station at the mouth of the Little Spokane.

Leaving the subject of the Spokane River here, I will remark upon the other streams flowing into the Columbia below the mouth of Snake River, and will return to discuss more fully the expediency of operating on the Spokane.

As before mentioned, the transcontinental railroad, after leaving the Spokane River, crosses the great plain of the Columbia and the dry bed of the ancient Lake Lewis, and does not strike the Columbia or any of its tributaries until it reaches the mouth of Snake River. From the mouth of Snake River it follows the Columbia down past The Dalles* and through the Cascade range of mountains almost to its terminus at Portland.

Of course the Columbia itself below Snake River, and Snake River anywhere near its mouth, are not to be thought of in connection with

* To avoid giving a wrong impression, perhaps I had better state here that the Northern Pacific Railroad proper terminates at Wallula Junction, Wash., at the mouth of the Walla Walla River, and that thence to Portland the railroad is owned and operated by the Oregon Railroad and Navigation Company.

a salmon-breeding station, their great volume and width making it wholly impracticable to collect any large number of spawning salmon from them. Below Snake River on the north or Washington side of the Columbia there are many salmon streams flowing into it, as Alder Creek, Klikitat River, Wind River, Washougal River, Lewis River, and Cowlitz River, besides many others; but, with the exception of perhaps the Cowlitz and Klikitat, they are all short, diminutive rivers which would never furnish breeders enough to supply any great number of eggs, and although the Cowlitz and Klikitat are of greater size and would yield a larger supply of eggs, they nevertheless could not furnish enough to warrant the establishment of a salmon-breeding station anywhere along their course. On the south or Oregon side of the Columbia its tributaries are much larger, but each one of them is open to some objection which would be fatal to the collecting and distributing of salmon eggs on a large scale.

The first river below Snake River, on the Oregon side of the Columbia, is the Walla Walla.* This river, although on the same side of the Columbia that Oregon is, is nevertheless in Washington Territory, as the Columbia from the mouth of the Snake River to a few miles below Wallula lies wholly in Washington Territory. The larger affluents of the Walla Walla River rise in the Blue Mountains, about 100 miles east of the Columbia. About 15 miles from the Columbia they become united, and now, under the name of the Walla Walla River, their combined waters empty into the Columbia at Wallula Junction. Although several persons have recommended the Walla Walla as a good river for our purpose, and although in times of high water many salmon run up this stream, it is nevertheless, I am convinced, too small a river to conduct any large operations on in the way of collecting salmon eggs. The river is scarcely more than 60 feet in width at low water, and shallow a quarter of a mile from its mouth; and a river of this size would not carry a sufficient volume of water to induce salmon enough to enter it to furnish any great number of eggs in these times of canneries; for it should be remembered that the immense canning operations carried on along the Columbia River have entirely revolutionized matters, as far as the abundance of salmon eggs is concerned. Twenty years ago, before the business of canning salmon on the Columbia was inaugurated, salmon literally swarmed up all the small creeks and little tributaries of the main river in such immense quantities that several million eggs could, without doubt, have been easily collected from the spawning fish at the head of comparatively insignificant streams; but that day has gone by, probably forever. The vast number of nets that are being continually dragged through the water at the canneries on the main river during the fishing season catch millions of full-grown salmon on their way up the river to spawn, and of course reduce to a corresponding extent the number of parent fish that reach the spawning-grounds.

* Three hundred and twenty-five miles from the mouth of the Columbia.

The comparatively few that succeed in running the gauntlet of the innumerable nets in the main river would, if they could be gathered together at one spot, still be enough to supply a great many million eggs; but those which ascend the river above the nets, instead of all going to one place, separate and divide up among the hundreds of tributaries, large and small, that help to form the great Columbia. Consequently a very small percentage, indeed, of the few salmon that get by the nets are to be found in any one manageable stream, unless some peculiar natural causes exist at some specified place to make that point an exception to the general rule. It is accordingly useless to look now to small streams which are subject to ordinary conditions for a large supply of salmon eggs, however abundant the salmon used to be in them in the former and better days of these salmon rivers.

The same objection which applies to the Walla Walla applies also to the Umatilla, * which is the next river entering the Columbia from the south. This river is much larger than the Walla Walla, but is not large enough to induce many salmon to leave the Columbia and ascend its current. In 1877, I was told that this river would be a good one for salmon-breeding, but a thorough investigation of it proved the contrary. I built across the river, about half a mile from its mouth, a rack similar to that which we are accustomed to put across the McCloud River in the spawning season in order to arrest the course of the salmon, and had it watched for two or three months in order to ascertain the magnitude of the salmon run. The result was that the run proved to be wholly inadequate for the collecting of a large number of eggs. So the Umatilla was abandoned.

Willow Creek comes next to the Umatilla, but is even smaller than that river, and consequently may be considered entirely out of the question.

The John Day River,† which comes next, rises in the Blue Mountains and, swollen by many tributaries, empties into the Columbia about 65 miles below the Umatilla. This river is large enough, but there are no accessible places on any part of it where fishing for breeders could be successfully carried on. At some future day, when railroads have become more abundant in Oregon, a suitable place may be found on the John Day which would also be accessible, but there are none at present.

Seventeen miles below the John Day River, the Deschutes‡ empties, splashing and foaming over the rocks, with a rapid current, into the Columbia. This river heads in the Cascade Range, at Mount Theilsen, nearly as far south as the forty-third parallel, while a more eastern branch arrives from as far east as the southwestern spurs of the Blue Mountains. The Deschutes is a model salmon river, cold, large, and

* Three hundred and two miles from the mouth of the Columbia.

† Two hundred and thirty-eight miles from the mouth of the Columbia.

‡ Two hundred and twenty-one miles from the mouth of the Columbia.

wide, rising in high mountains, flowing with a swift current, and finally emerging from its deep-sided cañon with great force, where it plunges into the Columbia River. It may not be generally known that a strong, rapid current of cold water is the most effective agent there is for inducing breeding salmon to turn from their course up a large river. It is very much a matter of chance whether they enter a river, even a large one, which is still and deep at its mouth. Such tributaries will certainly not attract the salmon into them from any great distance out in the main river. The Umatilla is a stream of this character; also the Willamette, and to some extent the Cowlitz. Many of the Columbia River salmon that are pursuing their upward course near the south bank of the river will very likely, when they reach these streams, be following the shore line, and in that way may be led into these rivers; but the salmon that are coming up on the other side of the Columbia, or are pursuing a middle course, will keep their course and disregard these streams that make so little impression on the main river. But such rivers as the Deschutes, which pour a cold, vigorous, swift-running volume of water into the main river, that makes itself felt to the further shore and for many rods below its mouth—such rivers call salmon up their channels by shoals, not only from their own side of the river but also from the opposite shore. These rivers always have a great run of salmon, and the Deschutes on this account would be a favorable stream to operate upon for collecting salmon eggs were it not for one drawback, and that a serious one, viz., It is unmanageable, for it is too large and violent a stream to control. As, I think, I have previously explained, the mere fact that the conditions for drawing a net in a salmon river are favorable does not by any means make it a favorable place for a large salmon-breeding station. To secure the necessary conditions of success, the river must be of such a character that the salmon can be stopped in some good seining place by erecting a temporary obstruction across the river. This could not be done on the Deschutes except at a very great expense. About 30 miles up the river, however, at a place called the "crossing" of the Deschutes, or sometimes simply Deschutes, there is a high fall which, except at very high water, keeps the salmon from going up any higher. Here the conditions are reversed. If now the river below was quiet enough to allow the successful drawing of the seine, this would be a good place for a breeding station, but the river here passes through a high rocky cañon with such violence as to render the drawing of a net impracticable. There are some other objections of less importance, but the one mentioned is enough. This point might, nevertheless, be a favorable one, if the falls themselves and the land around the falls could be secured, but this spot has been taken up by a settler who moved there many years ago and who now holds the premises at so high a figure as to make it very desirable to find a place somewhere else if possible.

The next large stream down the Columbia is the Big Sandy, which is a good salmon river, and probably has towards its headwaters some

favorable places for collecting salmon eggs, but at present they are not easily accessible. About 20 miles below the Big Sandy, the Willamette* slowly discharges its immense volume of water into the Columbia, which here seems not much larger than itself. If the slow Willamette poured its great stream into the Columbia as rapidly and forcibly as the Deschutes does, probably more than half of the Columbia River salmon would turn aside into the Willamette, but the Willamette is so still and apparently so almost motionless where its waters join those of the Columbia that but few salmon, relatively speaking, ascend the Willamette. Most of those entering the river find their way up past the city of Portland, and on 12 miles further to the Clackamas. This is a cold, swiftly-running river that empties into the Willamette just below Oregon City; its cold, swift current, which heads in the snow-covered flank of Mount Hood, attracts a large proportion of the salmon from the larger but warmer river, and even those that go by go only half a mile further, where their course is abruptly checked by the Oregon City Falls, which, at most stages of water in the river, entirely prevent the salmon from going any farther up. The salmon thus arrested in their upward progress along the Willamette, after making ineffectual attempts to jump the falls, after awhile drop back discouraged as far as the mouth of the Clackamas, and as soon as they feel again the cold vigorous rush of the Clackamas, immediately shoot up this river and join the great army of salmon that have preceded them up the same river. It will be inferred from this description that most of the salmon coming up the Columbia finally find their way into the Clackamas. This inference is entirely true. It was this which led to the establishment of a salmon-breeding station on this river in 1877 by the Oregon and Washington Fish Propagating Company. This station, which a series of misfortunes caused to be finally abandoned, is undoubtedly well situated for the taking of a great many salmon eggs. It is, however, somewhat difficult to operate it, and perhaps it will be found that some other point farther up the basin of the Columbia will combine many of its advantages without being subject to its disadvantages.

From the mouth of the Willamette to the sea all the streams emptying into the Columbia are short and small, and there are none which would command a moment's attention as a suitable place for a large salmon-breeding station.

From what has been stated above, it will be seen that from the head of the North or Clarke's Fork, which forms one of the two great arteries that combine to form the Columbia—the Snake River being the other—and which rises in the Continental divide of the Rocky Mountains between Deer Lodge and Helena, Mont., to the Pacific Ocean, there is not a place lying near the line of the Northern Pacific which unites all the conditions required for the carrying on of a salmon-breeding station on a large scale, except possibly the one referred to on the Little Spokane

*One hundred and eight miles from the mouth of the Columbia.

River. Some places supply some of the requisite conditions, others furnish what these have not, but none of them; with this one exception, combines all the needful conditions.

It seems surprising at first that this should be so. It seems surprising that there are not many points along the hundreds of miles of the Columbia and its northern fork where plenty of salmon eggs could be obtained and distributed, but nevertheless there are not. As this presents such a curious and interesting question, let us glance for a moment at the conditions that are required for the operating of a large and successful salmon-breeding station; and in order to bring out the subject with more distinctness, I will enumerate these conditions and consider them in regular order. Taking them in the order of their relative importance they seem to present themselves nearly as follows:

1. Abundance of breeding salmon.
2. Accessibility of location.
3. An adequate supply of water.
4. Convenience of location for obtaining water.
5. Availability of location.
6. Facility for catching parent fish.
7. Facility for arresting the upward progress of the breeding salmon.
8. Security from high water and attendant dangers.

1. ABUNDANCE OF BREEDING SALMON.—This first condition, viz., of the presence of an abundant supply of salmon, is such an obvious one that nothing more need be said about it. Of course there must be plenty of salmon, for a salmon-breeding station without the salmon would be like the play of Hamlet without the part of Hamlet. The Umatilla and Walla Walla Rivers are examples of rivers possessing all the conditions just enumerated, except this one—an abundance of salmon.

2. ACCESSIBILITY OF LOCATION.—Hardly less indispensable than the abundance of salmon is the accessibility of a salmon-breeding location. If it is so far removed from the traveled thoroughfares that the station could not be built, nor the eggs distributed, except at a cost that would practically be a prohibitory one, the location is of course of no value, no matter how abundant the salmon are or how favorable the other conditions may be. Several places on the great bend of the Columbia, between Priest Rapids and Lake Pend d'Oreille, which cannot be approached within 50 or 100 miles, except by very bad roads and trails, are illustrations of the absence of the essential element of accessibility.

3. AN ADEQUATE WATER SUPPLY.—Next in rank of importance seems to come the presence of a sufficient and suitable supply of water for hatching. Where this condition is lacking it is hardly worth while either to go to the expense of putting up hatching works or to make the attempt to collect a large number of eggs; for although, provided there is a considerable water supply, a correspondingly large number of eggs may often be matured for shipment or hatched, nevertheless an inadequate supply of water is not only always a source of care and uneasiness,

but is also a standing temptation to the operator to hatch more eggs than it is capable of doing. The result of this, of course, is usually a disastrous loss. Then, again, if a dry season should come, or one otherwise unfavorable to the supply of water, that season might prove almost an entire failure. It is consequently hardly desirable to undertake the hatching of salmon on a large scale without being sure of having plenty of water. Indeed, to be short of water in the hatching season is so annoying, not only from the causes just mentioned, but for various other reasons, that I would not want to have anything to do with a hatchery that did not have a large, superabundant, and unfailing supply of water. The first station of the United States Fish Commission on the McCloud River was a very good example of the absence of this condition. The station combined almost all the conditions except this one, and those who carried it on the only season that it was in existence will never forget the great care and anxiety that were caused by the insufficient supply of water, or the alarm that was always felt when hot and dry weather shrunk the little supply that we had, and there was danger that all the eggs would be lost in consequence.

4. CONVENIENCE OF LOCATION FOR OBTAINING SUITABLE WATER.—This condition may seem at first sight to be identical with the last, but a second look will show that it is not only a different one, but one that may often be wanting where the other is unexceptionable. This is not an uncommon occurrence. You may have a large river full of salmon, plenty of water, and plenty of fish, and not be able to use any of the water for hatching the eggs that are taken. I refer now to an automatically provided supply of water. For I am, of course, aware that wherever there is water it can be raised to any reasonable height by steam-pumps and other agencies; but steam-pumps are expensive to begin with; they involve a current expenditure in the running of them, and are never wholly free from risk. It is consequently always desirable to provide the water for a hatching station automatically, and no place where this cannot be done can be said to combine all the conditions desirable for a successful hatching station.

It sometimes happens that sufficient water can be brought to the hatching house without much inconvenience, but owing to its becoming warm or muddy on its way it may be unfit to use after it reaches there. It also happens sometimes that, although abundant and suitable water for the hatching house may be very near, there may be great inconvenience and risk in bringing it to where it is wanted. It is consequently quite important in selecting a hatching station to find a place where the water can not only be found in abundant supply, but where it can be conveniently brought to the hatching house in suitable condition. Probably more ingenuity has been exercised by fish-breeders in their contrivances for bringing suitable water to their hatching houses than in any other department of their operations. Windmills, steam-pumps,

current-wheels, hydraulic rams, siphons, and about all of the more common appliances for raising water to a higher level have been resorted to, in order to utilize what was otherwise a good breeding spot with plenty of water for the fish to live in. This fact shows how desirable it is to have a breeding place where the hatching water comes naturally to the eggs and involves no expense in obtaining it.

The salmon-breeding works that were put up in Oregon, on the Clackamas River, in 1877, for the purpose of hatching Columbia River salmon, furnish a singular illustration of this. The spot selected for this station seemed to be favorably situated for the work, particularly in regard to the water supply for the eggs, for just behind the site of the hatching house was a large stream of water called Clear Creek, which furnished an unlimited supply of good water at a suitable height to be introduced into the hatching house. When, however, we came to undertake to dam up the creek for the purpose of taking water from it, it was found that the bed of the creek was quicksand to an indefinite depth, and that neither hard-pan nor bed-rock could be reached. Consequently, after various persistent but fruitless attempts to find a secure place across the creek for a dam, the creek as a water supply for hatching had to be given up. Water for the purpose was afterwards obtained the same year by other means, but only with considerable difficulty and at a large expense; and when the company which built the establishment concluded the next season to risk the experiment of damming up Clear Creek, the first large freshet carried away the dam and left the salmon eggs in the hatching house without water, which resulted in a serious loss.

5. AVAILABILITY OF LOCATION.—It would seem at first sight as if any favorable location for a salmon-breeding station would be available, but this is far from being the fact. For instance, some falls might be found in a good salmon river where every facility could be afforded for taking and hatching eggs, but if these falls belonged to some one who had taken up a claim there, the site could not be secured perhaps, except at an enormous price or an enormous rental, which would practically place it out of reach. Or, perhaps, a good place could be found on a river which was considerably settled above the proposed site of the fishery. This would also make it unavailable, because the upper settlers would in all probability never allow a dam to be put across the lower portion of the river to obstruct the ascent of the salmon, and without such obstruction no great quantity of salmon could be taken anywhere in the United States at least, unless it might be at the foot of some falls or natural obstruction.

If we needed an example to illustrate the absence of this condition we might find it at the crossing of the Deschutes River, where the falls which stop the salmon and where the land adjacent, are owned by a settler and held by him at a very high figure; or on the Little Sacramento, in California, where many salmon eggs could be taken and hatched if

a dam was put across the river, but where the settlers are so numerous above that such an obstruction would not be tolerated.

6. Facility for catching parent fish.—This is not so essential a condition as the preceding ones, because labor and dynamite can usually create a good seining ground almost anywhere. It is an important condition, however, because a poor seining ground is a great drawback and a very serious annoyance at a salmon hatchery, and in many places it would cost a great deal of money to make a good seining ground with labor and dynamite. Moreover, such artificially prepared grounds are torn to pieces, so to speak, every winter by the violence of the high water during floods. This difficulty of securing a good natural seining ground is more often encountered than one would suppose. An inexperienced person might perhaps think that a net could be dropped anywhere in a river where fish abounded, and be drawn in successfully. But it is not so. Indeed there are many things which bar out seining in a river. For instance, a seine cannot be hauled with any success in a swift and shallow place, for the net cannot be drawn inshore with any success, even supposing the river bottom to be comparatively smooth and level. Neither is it of any use to haul where there are deep holes in the river bed, for the fish will go into the holes as the seine passes over them, and will escape. Again, it is impossible to haul a seine where there are large bowlders, or worse still, projecting points of rock in the seining ground, as these obstructions will foul the net every time, and if the fishing is persisted in will soon tear the net to pieces. As suggested above, a sufficient expenditure of time and money will make a good seining ground out of a poor one, but it is often a very expensive undertaking, and when accomplished the seining ground that has in this way been artificially made will never be so good a ground for fishing as one that has been prepared, or nearly prepared for use, by nature.

As an example of the difficulty of finding a good seining ground I might mention the McCloud River, California, where, I suppose, there is not in the whole sixty miles of the course of the river a single place where there is a good seining ground or where a first-class seining ground could be made, except at the salmon-breeding station of the United States Fish Commission two miles from the mouth of the river.

7. Facility for arresting the progress of the breeding salmon up the river—As every one knows, migratory fish, particularly those of the salmon family, develop an irrepressible instinct to ascend the rivers which contain their spawning grounds. So strong and violent, indeed, is this instinct in salmon that they will force their way over all obstacles not absolutely insurmountable, in their endeavors to reach the sources of the rivers which they enter to deposit their spawn. Taking advantage of this instinct, the salmon-breeder finds an easy method for holding them at the particular place where he wants them to stay, by throwing across the river a dam or fence, which allows the water to pass down but prevents the salmon from going up. Their in-

stinct keeps them from going down the river, and the obstruction keeps them from going up the river, so that they are practically confined or, as the Californians say, "corraled" in the river just below the dam. The dam is usually constructed just above the fishing ground, where the fish collect in great numbers, and where they are not only safely confined but easily caught. This method of collecting the parent salmon during the spawning season in one place by putting an obstruction across the river is absolutely indispensable for taking eggs in great numbers (unless nature has already provided an equally effective obstruction), for all the salmon, even in the most favorable localities, that could be caught while passing on their way up the river would never be enough to furnish any very large quantity of eggs. Now, in selecting a site for a salmon-breeding station this consideration must always be borne in mind, for it is an essential condition of sucess. I need hardly say that across many rivers, especially the large and rapid ones, it is impracticable to place such an obstruction as has just been mentioned; and many a good salmon river has been abandoned as a good breeding point because, although salmon enough ascend the river, they could not be collected together in sufficient numbers anywhere, owing to the impracticability of constructing a dam or fence across its channel.

8. SECURITY FROM HIGH WATER AND ITS ATTENDANT DANGERS.—This is the last prerequisite of a salmon-breeding station which I will mention, but it is not by any means the least, nor is it a very easy one to secure. I know of but very few good salmon rivers that are not subject to dangerous and unmanageable freshets, and of course no prudent person would knowingly build a station that could be destroyed or rendered useless by high water. It might perhaps be carried on for one or two seasons, but it is naturally only a question of time when great mischief would be caused. Sooner or later the rise in the river will come and calamity will ensue.

THE LOCATION AT THE MOUTH OF THE LITTLE SPOKANE RIVER.

I return now to the consideration of the qualifications of the mouth of the Little Spokane River as a suitable place for conducting large operations in collecting and distributing salmon eggs. I think it is safe to say that we are sure that this point combines all the favorable conditions just enumerated, with possibly the very important exception of the first and most essential one of all, viz., the abundance of breeding salmon. This was a question which could not be determined during my examination of the place in July, because the run of breeding salmon does not reach the Little Spokane until August, September being probably the month when the spawning salmon are most abundant. All the information we could collect on this very essential point of the abundance of salmon in the breeding season was what the Indians gave in their vague and unsatisfactory way, and, although this informa-

tion left the impression that a great many salmon came up in August, it by no means amounted to establishing a certainty.

With a view to obtaining more precise data on this subject, I engaged a man living at Spokane Falls to collect statistics in regard to the number of salmon caught by the Indians during the fall run. The statistics which were collected, however, are not by any means such as the exigencies of the case require. The Indian's information, given with the customary Indian explicitness, was that the salmon were as "thick as crickets," which means, of course, that they were very numerous, but might be intended to mean 1,000 or 50,000. Taking the most accurate statements that could be obtained and basing a fair calculation upon them, it appears that about 2,000 salmon were actually caught by the Indians this season (1883) at the mouth of the Little Spokane, and it is possible that many more than this number were caught. I should think that with white men's appliances and improved facilities for their capture the number of parent salmon caught by the Indians might be doubled. This would make 4,000 breeding salmon to operate with, which would give a yield probably of from five to ten million eggs. I do not wish to be understood that this is my opinion about it. I only say that if the statistics collected this year should prove reliable, there is a fair prospect of getting from five to ten million salmon eggs at the mouth of the Little Spokane during the spawning season. I consider, however, that the question of the abundance of the salmon at this point is far from being settled.

In the meantime, let us see how the mouth of the Little Spokane meets the other requirements of a large salmon-breeding station. Taking them in the order in which they have just been enumerated, accessibility of location comes next to the abundance of fish. Here the location at the Little Spokane possesses extraordinary advantages. Eight miles from the mouth of the river, over a remarkably hard and level road, is the town of Spokane Falls, a new but thriving and promising settlement of perhaps 1,200 inhabitants. This town is situated on the line of the Northern Pacific Railroad, and is in daily connection with the rest of the world by mail, telegraph, and railroad, the railroad being one of the great transcontinental thoroughfares of the country. These general facts alone are sufficient to show the accessibility of the location without the necessity of mentioning details.

The water supply at the mouth of the Little Spokane for hatching the eggs is practically unlimited. As there is a strong current in the river, and the water does not rise till after the spawning season and hatching season are over, the water can be raised safely from the river itself by a current-wheel, as at the McCloud River station, and this being the case, any required quantity of water can be brought to the hatching house at a small expense.

The location is also favorable for obtaining water conveniently. The river never rises more than a few feet, and consequently the hatching

house can be erected not very far above the low-water mark. A small current-wheel will therefore be sufficient to raise the water to the hatching house, and the adjacent land is so favorable for building on, that the wheel can be placed very near the hatching house, which will render unnecessary the construction of a long flume from the wheel to the hatching house. As the river does not rise till the hatching season is over, the wheel need not be protected from drift-wood or arranged with reference to the rising and falling of the water. These are great conveniences, and, on the whole, it may be said that the water supply may be safely depended upon in every respect.

The location is also remarkably favorable as to availability. Fortunately the adjacent country is still in its primitive state. When I visited the place in July (1883) many Indians were encamped on the river bottoms, but I saw no white men. It is true some claims near the river have been taken up by white men, but they are not valuable, and could be bought without much expense. It is therefore very probable that the site of a salmon-breeding station could be obtained without much cost; and as there are very few settlers up the river, and no towns or villages, no objection would probably be raised to obstructing the ascent of the salmon during the spawning season by a dam across the river.

The Little Spokane is also of such a character that it would be an easy matter to capture the breeding fish. Indeed, I think a seining ground could be arranged, so that nearly all the spawning fish that came up the river could be caught; and furthermore, it being close to the main Spokane River, it would not be difficult to run two seining grounds—one in each river—which would undoubtedly somewhat increase the yearly catch of breeders.

It will be a very easy matter to build a dam or salmon-rack across the river to keep the breeders on or near the seining ground. Indeed, the frail structure which we saw Indians successfully erecting across the river shows how easy it would be for white men, with their superior appliances, to put a salmon-rack across the river, such as would be required to answer the purposes of a salmon-breeding station. There being no drought or freshet on the river during the season's operations at the station—and indeed no natural changes at all in the river—a very simple and easily constructed dam would be perfectly safe. This is a great advantage, as it often proves a very difficult matter in a river subject to freshets in the hatching season to put in an obstruction that is perfectly safe.

And last, but not least, the maximum rise of the river during the year is so inconsiderable that there will never be any danger of the hatching house and other buildings being washed away, even if they are placed, as it is desirable they should be, close to the river.

Besides possessing the essential qualifications just enumerated for a salmon-breeding station, the Spokane location has many convenient

features about it to recommend it. In the first place, it is in a good timber country, where lumber can be easily and inexpensively obtained for building. Then the roads in all directions are hard and good, even during the rainy season, which is an advantage that can be fully appreciated by those who have lived in other parts of the Pacific coast, where the roads become practically impassable during the rainy season on account of the great depth of the mud. The ground is also almost level from the mouth of the Little Spokane to the town of Spokane Falls, which would make communication with the town and freighting to and from the breeding station very easy. The climate also is a great recommendation to this place; as it is never very cold or very hot.

By glancing over what has just been said about the mouth of the Little Spokane it will be seen that it is known to be, in all the essential points but one, an unusually favorable location for a salmon-breeding station. If it should prove to be capable of furnishing an abundance of breeders, I should not hesitate to recommend it emphatically as one of the best situations to be found anywhere for taking and distributing salmon eggs. If, however, it should fail to supply the required quantity of spawning salmon, I do not know where we could look for any one place on the Columbia River or its North Fork which by itself would be adequate and satisfactory, and I think we should then be reduced to the necessity of going farther from the railroad or erecting two or three separate stations at different points. Of these two alternatives it would probably be most prudent to choose the latter, on account of the extreme difficulty of constructing a station for carrying on the work of taking, distributing, and hatching salmon eggs at any great distance from the railroad.

I think it proper to state here that perhaps the finding of another such place as the McCloud River station, in California, should not be expected. It may be that the McCloud River station has spoiled us for all other places by leading us to expect too much. Possibly there are no other places in the United States, Alaska excepted, where nearly twenty million salmon eggs could be obtained in one year*. It certainly is not reasonable to expect such a combination of favorable circumstances to occur again as is found at the McCloud station. It is a combination, against the second occurrence of which there are many chances to one. In the case of the McCloud station, it so happened that all the other main tributaries of the Sacramento, with one or two exceptions, were so filled with the mud and dirt ("slickens") from the hydraulic mines above that no salmon would enter them. These rivers were as completely closed to the spawning salmon as if an impassable dam had been built at their mouths on purpose to keep them out. The consequence was that all the salmon passed by them, and, the McCloud

* In 1878, 14,000,000 salmon eggs were placed in the hatching house at the station on the McCloud River, California, and several millions more could undoubtedly have been obtained if needed.

being the coldest and most inviting of the tributaries that were left, they swarmed up this river in vast quantities.

Besides, a good seining ground being found at the junction of the river with the California and Oregon stage line, the station was enabled to be built at a convenient place for communication with the outside world. A good place was found for putting a rack or fence across the river just above the seining ground, so that the vast hosts of salmon going up the river were stopped just where they were wanted most. There was an abundance of good water for hatching and it was easily obtained. All the land about the river was wild land, so that the site of the fishery cost nothing, and no one objected to the rack that was put across the river to stop the salmon, because only one white man lived up the river. Here was a collection of first-class qualifications which it is obvious would be extremely unlikely to be found combined together again, and it is possible that, in point of fact, no other such place will be found again south of the British possessions. If this should prove to be the case, then we should have to be satisfied with stations of smaller capacity and more of them, unless, as just suggested, it is thought desirable to go to a greater distance from railroad communication. In the meantime it seems safe to say that the mouth of the Little Spokane River appears at present to be the most favorable point now known for establishing a salmon-breeding station on the Columbia or its tributaries, which shall at the same time be near the line of the Northern Pacific Railroad.

I wish to add, however, that if Washington Territory and the State of Oregon, between which the lower Columbia flows, could agree upon a code of good protective laws for the salmon, the Clackamas River would again teem with salmon as before, and in that event perhaps the best point for a breeding station would be on that river where the station of the Oregon and Washington Fish Propagating Company was built in 1877. Before the times of canneries and excessive netting of the salmon in the lower Columbia, the Clackamas in Oregon was as good a salmon river as the McCloud in California, and if the salmon should ever be allowed to reach it, it might be again. There is no ground for the objection that the Clackamas salmon are an inferior variety of fish, for it has been proved repeatedly and indisputably that the Clackamas salmon are the Spring or Chenook salmon (*Oncorhynchus quinnat*) [*O. chouicha* (Walb.) J. & G.], and of precisely the same variety as those which are canned at the mouth of the Columbia, and which are held to be of the highest value for canning. Nor is the difficulty of obtaining water for the hatching house at this point a very serious objection, for if an abundance of breeders could be obtained it would warrant the incurring of sufficient expense to overcome this difficulty. If, therefore, the laws should ever protect the salmon of the Columbia, so that they could reach the mouth of the Clackamas, it might be found

the most feasible plan for obtaining salmon eggs on a large scale to restore the old breeding establishment on this river.

On my return from California, in September, 1883, so favorable an opportunity was offered for making some investigations in regard to the run of salmon in the upper tributaries of the Snake River or South Fork of the Columbia that I somewhat exceeded my instructions, which limited my inquiries to that portion of the Columbia River which lies along the line of the Northern Pacific, and went to Eagle Rock, Idaho, where the Utah and Northern Railroad crosses the Snake River, with some hope of finding a suitable place for salmon hatching, but to my surprise I found that no salmon ever came up as far as Eagle Rock. At Pocatello, Idaho, which is the junction of the Utah and Northern Railroad and the Oregon Short Line, I found also that no salmon came up to American Falls, which is 25 miles below Pocatello. In fact, all salmon are stopped in their progress up the Snake River at the Great Shoshone Falls, in Idaho, which are about 80 miles from the American Falls and 107 miles from Pocatello. These falls are very high, and the salmon cannot get over them. The falls are not directly on the line of the railroad, but are 27 miles from the track of the Oregon Short Line Railroad, the point from which they are most accessible probably being the station of Shoshone. At these falls the salmon, I was told, collect in great numbers, and it is likely that this point may be found to be a good place for establishing a station for collecting salmon eggs and for hatching them.

I will close by mentioning one more place in this connection, which may some time be found to be a favorable place for a station. This is Salmon City, on the Salmon River, in Idaho. I have the authority of Captain Bendire for stating that salmon can be found here in great quantities in the spawning season, and it probably has other desired qualifications, but it is 100 miles from the nearest railroad point, from which it is reached by a rough and hilly road. If it was not for this objection, a salmon-hatching station might be established here, but its comparative inaccessibility is a serious drawback to the location, and it ought not to be taken into consideration while other good and more accessible points can be found.

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IV.—THE BRITISH SEA FISHERIES ACT, 1883.

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AN ACT to carry into effect an International Convention concerning the fisheries in the North Sea, and to amend the laws relating to British sea fisheries. [August 2, 1883.]

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the lord's spiritual and temporal, and commons, in this present Parliament assembled, and by the authority of the same, as follows:

Preliminary.

1. This act may be cited as the Sea Fisheries Act, 1883.

Confirmation of convention.

2. The convention set out in the first schedule to this act (referred to in this act as the convention) is hereby confirmed, and the articles thereof shall be of the same force as if they were enacted in the body of this act.

Fishery regulations.

3. It shall be lawful for Her Majesty from time to time, by order in council, to make, alter, and revoke regulations for carrying into execution this act, and the intent and object thereof, and for the maintenance of good order among sea-fishing boats, and the persons belonging thereto, and to impose fines not exceeding £10 for the breach of such regulations.

4. If within the exclusive fishery limits of the British Islands any person, or if outside those limits any person belonging to a British sea-fishing boat, (*a*) acts in contravention of articles 13 to 22 (both inclusive) of the first schedule to this act, or any of them; or (*b*) causes injury to any person in any one or more of the following ways, namely, by assaulting any one belonging to another sea-fishing boat, or by causing damage to another sea-fishing boat, or to any property on board thereof, or belonging thereto; or (*c*) fishes for oysters or has on board

his boat any oyster dredge within any seas and during any time within and during which oyster fishing is prohibited by law, or by any convention, treaty, or arrangement to which this act may be hereafter applied, such person shall be liable, on summary conviction, to a fine not exceeding £50, or, in the discretion of the court, to imprisonment for a term not exceeding three months, with or without hard labor.

5. If within the exclusive fishery limits of the British Islands, any person, or if outside those limits any person belonging to a British sea-fishing boat, (*a*) uses any instrument for the purpose of damaging or destroying, by cutting or otherwise, any fishing implements belonging to another sea-fishing boat, except in the cases provided for by articles 20 and 21 of the first schedule to this act; or (*b*) takes on board or has on board such boat any instrument serving only or intended to damage or destroy fishing implements, by cutting or otherwise, such person shall be liable on summary conviction to a fine not exceeding £50 or in the discretion of the court to imprisonment for a term not exceeding three months, with or without hard labor, and the instrument shall be liable to be forfeited.

6. The regulations respecting lights for the time being in force under the acts relating to merchant shipping shall, so far as they relate to sea-fishing boats, be deemed to be provisions of this act and may be enforced accordingly, and a sea-fishery officer shall for that purpose, in addition to his powers under this act, have the same powers as are given to any officer by the said acts relating to merchant shipping.

Exclusive fishery limits.

7. (1) A foreign sea-fishing boat shall not enter within the exclusive fishery limits of the British Islands, except for purposes recognized by international law, or by any convention, treaty, or arrangement for the time being in force between Her Majesty and any foreign state, or for any lawful purpose.

(2) If a foreign sea-fishing boat enters the exclusive fishery limits of the British Islands, (*a*) the boat shall return outside of the said limits so soon as the purpose for which it entered has been answered; (*b*) no person on board the boat shall fish or attempt to fish while the boat remains within the said limits; (*c*) such regulations as Her Majesty may from time to time prescribe by order in council shall be duly observed.

(3) In the event of any contravention of this section on the part of any foreign sea-fishing boat, or of any person belonging thereto, the master or person for the time being in charge of such boat shall be liable on summary conviction to a fine not exceeding, in the case of the first offense, £10, and in the case of a second or any subsequent offense, £20.

Registry of British sea-fishing boats.

8. (1) Section 22, 23, 24, and 26 of the sea fisheries act, 1868 (which relate to the registry of British sea-fishing boats), shall have effect as

if articles 5 to 12 (both inclusive) of the first schedule to this act were therein referred to in addition to the articles of the first schedule to that act in the said sections mentioned, and as if offenses under this act were offenses in the said sections mentioned; provided that nothing in the said sections shall be deemed to authorize any foreign sea-fishery officer to do anything which he is not, under the first schedule to this act, authorized to do.

(2) Section 176 of the customs consolidation act, 1876, shall not apply to any British sea-fishing boat entered or registered in pursuance of the said sections of the sea fisheries act, 1868.

Miscellaneous.

9. (1) There shall not be manufactured or sold or exposed for sale at any place within the British Islands, any instrument serving only or intended to damage or destroy fishing implements, by cutting or otherwise.

(2) In the event of any contravention of this section a person guilty thereof shall be liable, on summary conviction, to a fine not exceeding £50, or, in the discretion of the court, to imprisonment for a term not exceeding three months, with or without hard labor, and the instrument shall be liable to be forfeited.

10. The boats and things specified in article 25 of the first schedule to this act shall be deemed to be "wreck" within the meaning of any acts relating to merchant shipping, so however that the provisions of the said article shall be duly observed.

Enforcement of act.

11. (1) The provisions of this act and of any order in council under this act or under the sections of the sea fisheries act, 1868, amended by this act, shall be enforced by sea-fishery officers, either British or foreign.

(2) The following persons shall be British sea-fishery officers; that is to say, every officer of or appointed by the Board of Trade, every commissioned officer of any of Her Majesty's ships on full pay, every officer authorized in that behalf by the admiralty, every British consular officer, every collector and principal officer of customs in any place in the British Islands, and every officer of customs in the British Islands authorized in that behalf by the commissioners of customs, every divisional officer of the coast guard, and every principal officer of a coast-guard station.

(3) The following persons shall be foreign sea-fishery officers; that is to say, the commander of any vessel belonging to the Government of any foreign state bound by the convention, and any officer appointed by a foreign state for the purpose of enforcing the convention, or otherwise recognized by Her Majesty as a sea-fishery officer of a foreign state.

12. For the purpose of enforcing the provisions of this act and of any order in council under this act or under the sea fisheries act, 1868, as

amended by this act, a British sea fishery officer may with respect to any sea-fishing boat within the exclusive limits of the British Islands and with respect to any British sea-fishing boat outside of those limits, exercise the following powers:

(1) He may go on board it.

(2) He may require the owner, master, and crew, or any of them, to produce any certificates of registry, licenses, official logbooks, official papers, articles of agreement, muster rolls, and other documents relating to the boat or to the crew, or to any member thereof, or to any person on board the boat, which are in their respective possession or control on board the boat, and may take copies thereof or of any part thereof.

(3) He may muster the crew of the boat.

(4) He may require the master to appear and give any explanation concerning his boat and her crew, and any person on board his boat, and the said certificates of registry, licenses, official logbooks, official papers, articles of agreement, muster rolls, and other documents, or any of them.

(5) He may examine all sails, lights, small boats, anchors, grapnels, and fishing implements belonging to the boat.

(6) He may seize any instrument serving only or intended to damage or destroy fishing implements, by cutting or otherwise, which is found on board the boat or in the possession of any person belonging to the boat.

(7) He may make any examination or inquiry which he deems necessary to ascertain whether any contravention of the provisions of this act, or of any such order of council as aforesaid has been committed, or to fix the amount of compensation due for any damage done to another sea-fishing boat, or to any person or property on board thereof or belonging thereto, and may administer an oath for such purpose.

(8) In the case of any person who appears to him to have committed any such contravention he may, without summons, warrant, or other process, both take the offender and the boat to which he belongs and the crew thereof to the nearest or most convenient port, and bring him or them before a competent court, and detain him, it, and them in the port until the alleged contravention has been adjudicated upon.

13. For the purpose of carrying into effect the convention, and of exercising and performing the powers and duties thereby vested in and imposed on cruisers and commanders of cruisers, a foreign sea-fishery officer may, with respect to any British sea-fishing boat, and any sea-fishery officer, whether British or foreign, may, with respect to any foreign sea-fishing boat to which this act for the time being applies, exercise any of the powers conferred by this act on British sea-fishery officers: *Provided*, That (*a*) nothing in this section shall authorize a sea-fishery officer to do anything not authorized by the convention; and (*b*) the port to which any sea-fishing boat or any person belonging thereto is taken shall, except where the nationality of such boat is not evidenced by official papers, be a port of the state to which such boat belongs.

14. (1) A sea-fishery officer shall be entitled to the same protection in respect of any action or suit brought against him for any act done or omitted to be done in the execution of his duty under this act, as is given to any officer of customs by the customs consolidation act, 1876, or any act amending the same, and (with reference to the seizure or detention of any ship) by any act relating to the registry of British ships.

(2) If any person obstructs any sea-fishery officer in acting under the powers conferred by this act, or refuses or neglects to comply with any requisition or direction lawfully made or given by or to answer any question lawfully asked by any sea-fishery officer in pursuance of this act, such person shall be liable, on summary conviction, to a fine not exceeding £50, or to be imprisoned for a term not exceeding three months, with or without hard labor.

Legal proceedings.

15. (1) Where on the conviction of any person under this act for an offense it appears to the court that any injury to person or property has been caused by the offense, the court may by such conviction adjudge the person convicted to pay in addition to any fine a reasonable sum as compensation for such injury, and such sum may be recovered as a fine under this act, and when recovered shall be paid to the person injured.

(2) Any compensation specified in a document signed in accordance with article 33 of the first schedule to this act, or fixed by a sea-fishery officer in accordance with any submission to arbitration, may be recovered as a simple contract debt, and in England may also be recovered as a civil debt before a court of summary jurisdiction.

(3) In a proceeding against any person for the recovery of such last-mentioned compensation, the formal document referred to in the said article, or an award of a sea-fishery officer in pursuance of a submission to arbitration signed by the person liable to pay such compensation, shall be sufficient evidence that such person is liable to pay the compensation specified in such document or award.

16. (1) Offenses under this act may (save as otherwise provided) be prosecuted, and fines under this act may be recovered in a summary manner; that is to say, (*a*) in England before a justice or justices, in manner provided by the summary jurisdiction (English) acts; (*b*) in Scotland in manner provided by the summary jurisdiction (Scotland) acts, 1864 and 1881; (*c*) in Ireland within the police district of Dublin metropolis in manner provided by the acts regulating the powers and duties of the justices of the peace of such district, or of the police of such district, and elsewhere in Ireland in manner provided by the petty sessions (Ireland) act, 1851, and the acts amending the same; (*d*) in the Isle of Man, and the islands of Guernsey, Jersey, Alderney, and Sark, respectively, before any court, governor, deputy governor, deemster, jurat, or other magistrate, in the manner in which the like offense and fines are by law prosecuted and recovered, or as near thereto as circumstances admit.

(2) If any person feels aggrieved by any conviction under this act by a court of summary jurisdiction, or by any determination or adjudication of such court with respect to any compensation under this act, he may, where imprisonment is awarded without the option of a fine, or the sum adjudged to be paid exceeds £5, appeal therefrom as follows: (*a*) In England the appeal should be to quarter sessions in manner provided by the summary jurisdiction (English) acts; (*b*) in Ireland the appeal should be to the court of quarter sessions in manner directed by the petty sessions (Ireland) act, 1851, and the acts amending the same; (*c*) in Scotland, the Isle of Man, and the islands of Guernsey, Jersey, Alderney, and Sark, the appeal shall be to the court and in the manner in which appeals from the like convictions and determinations and adjudications are made.

17. (1) Any document drawn up in pursuance of the first schedule to this act shall be admissible in any proceeding, civil or criminal, as evidence of the facts or matters therein stated.

(2) If evidence contained in any such document was taken on oath in the presence of the person charged in such evidence, and such person had an opportunity of cross-examining the person giving such evidence and of making his reply to such evidence, the sea-fishery officer drawing up such document may certify the said facts, or any of them.

(3) Any document or certificate in this section mentioned purporting to be signed by a sea-fishery officer shall be admissible in evidence without proof of such signature, and if purporting to be signed by any other person, shall, if certified by a sea-fishery officer to have been so signed, be deemed, until the contrary is proved, to have been signed by such other persons.

(4) If any person forges the signature of a sea-fishery officer to any such document as above mentioned, or makes use of any such document knowing the signature thereto to be forged, such person shall be liable on summary conviction to imprisonment for a term not exceeding three months with or without hard labor, and on conviction on indictment to be imprisoned with or without hard labor for a term not exceeding two years, and the cost of the prosecution of any such person on indictment may be paid as in cases of felony.

18. For the purpose of giving jurisdiction to courts under this act, a sea-fishing boat shall be deemed to be a ship within the meaning of any act relating to offenses committed on board a ship, and every court shall have the same jurisdiction over a foreign sea-fishing boat within the exclusive fishery limits of the British Islands, and persons belonging thereto, as such court would have if such boat were a British sea-fishing boat.

19. Service of any summons or other matter in any legal proceeding under this act shall be good service if made personally on the person to be served, or at his last place of abode, or if made by leaving such summons for him on board any sea-fishing boat to which he may be-

long, with the person being or appearing to be in command or charge of such boat.

20. (1) Where any offense against this act has been committed by some persons belonging to a sea-fishing boat, the master or person for the time being in charge of such boat shall in every case be liable to be deemed guilty of such offense; provided that if he proves that he issued proper orders for the observance, and used due diligence to enforce the observance of this act, and that the offence in question was actually committed by some other person without his connivance, and that the actual offender has been convicted, or that he has taken all practicable means in his power to prosecute such offender (if alive) to conviction, he shall not be liable to any further punishment than payment of compensation for any injury caused by the offense.

(2) Any fine or compensation adjudged under this act may be recovered in the ordinary way, or, if the court think fit so to order, by distress or poinding and sale of the sea-fishing boat to which the offender belongs, and her tackle, apparel, and furniture, and any property on board thereof or belonging thereto, or any part thereof; provided that, where the boat is a foreign sea-fishing boat, the court may order that in lieu of any such distress the boat may be detained in some port in the British Islands for a period not exceeding three months from the date of the conviction, and the boat may be detained accordingly, and in such case shall not be distrained.

21. (1) The court adjudging any fine or forfeiture under this act may, if it think fit, direct the whole or any part thereof to be applied in or towards payment of the expenses of the proceedings; and, subject to such direction, all fines and the proceeds of all forfeitures recovered under this act shall, notwithstanding anything in any act relating to municipal corporations or otherwise, be paid into the exchequer in such manner as the commissioners of the treasury may direct.

(2) Forfeitures may be destroyed, sold, and disposed of as the court adjudging the forfeiture may direct.

22. (1) Nothing in this act shall prevent any person being liable under any other act or otherwise to any indictment, proceeding, punishment, or penalty, other than is provided twice for the same offense.

(2) Nothing in this act, or in any order in council made thereunder, nor any proceedings under such act or order with respect to any matter, shall alter the liability of any person in any action or suit with reference to the same matter, so that person shall be required to pay compensation twice in respect of the same injury.

Application of act.

23. If at any time after the commencement of this act any convention, treaty, or arrangement respecting sea fisheries is made between Her Majesty and any foreign state, it shall be lawful for Her Majesty by order in council to direct that all or any of the provisions of this act

shall, and the same shall accordingly (subject to the exceptions, restrictions, and conditions, if any, in the order mentioned) apply to the said convention, treaty, or arrangement, and have effect in like manner as if the said convention, treaty, or arrangement were set forth in the first schedule to this act, and were part of that schedule and were the convention referred to in this act.

24. If the provisions of this act are applied by order in council to any convention, treaty, or arrangement made in substitution for the convention set forth in the first schedule to the sea fisheries act, 1868, or for the convention and articles set forth in the schedule to the act of the sixth and seventh years of the reign of Her present Majesty, chapter 79, entitled "An act to carry into effect the convention between Her Majesty and the King of the French, concerning the fisheries in the seas between the British Islands and France," that last-mentioned act shall, after the date fixed by the said order for the application of this act, be repealed, but such last-mentioned act shall, until the said date or any earlier date at which the convention set forth in the first schedule to the sea fisheries act, 1868, comes into operation, continue in force so far as regards French sea-fishing boats and persons belonging thereto within the seas to which the said convention and articles set forth in the schedule thereto apply, so far as those seas are outside the exclusive fishery limits of the British Islands, and are not within the North Sea as defined in the first schedule to this act.

25. This act, so far as it applies to foreign sea-fishing boats outside of the exclusive fishery limits of the British Islands, and persons belonging thereto, and to foreign sea-fishery officers, shall apply only within the North Sea as defined by article 4 of the first schedule to this act, or within the seas specified in any convention, treaty, or arrangement to which this act may be applied by order in council made in pursuance of this act, and to the boats and officers of a foreign state bound by the convention in the first schedule to this act or by any convention, treaty, or arrangement to which this act may be applied, but save as aforesaid this act shall apply to the whole of the British Islands as defined by this act, and to the seas surrounding the same, whether within or without the exclusive fishery limits of the British Islands, and the royal courts of Guernsey and Jersey shall register this act in their respective courts.

Supplemental.

26. Orders in council made in pursuance of this act shall be published in the London Gazette, or otherwise published in such manner as the Board of Trade may direct for such sufficient time before they come into force as to prevent inconvenience.

27. The reference in section 18 of the sea fisheries act, 1868, to section 200 of the customs consolidation act, 1853, shall be construed to refer to section 170 of the customs consolidation act, 1876.

28. In this act, the expression "Sea fishing" shall not include fishing for salmon as defined by any act relating to salmon, but save as aforesaid, means the fishing for every description both of fish, and shell-fish, found in the seas to which this act applies, and the expression "Sea fisherman" and other expressions relating to sea fishing shall be construed accordingly; the expression "Sea-fishing boat" includes every vessel of whatever size, and in whatever way propelled, which is used by any person in sea fishing, or in carrying on the business of a sea fisherman; the expression "Fishing implement" means any net, line, float, barrel, buoy, or other instrument, engine, or implement used or intended to be used for the purpose of sea fishing; the expression "British Islands" includes the United Kingdom of Great Britain and Ireland, the Isle of Man, the islands of Guernsey, Jersey, Alderney, and Sark, and their dependencies; the expression "Exclusive fishery limits of the British Islands" means that portion of the seas surrounding the British Islands within which Her Majesty's subjects have, by international law, the exclusive right of fishing, and where such portion is defined by the terms of any convention, treaty, or arrangement for the time being in force between Her Majesty and any foreign state, includes, as regards the sea-fishing boats and officers and subjects of that state, the portion so defined; the expression "The admiralty" means the lord high admiral for the time being of the United Kingdom of Great Britain and Ireland, or any two or more of the commissioners for executing the office of lord high admiral of the United Kingdom; the expression "Consular officer" includes consul-general, consul, and vice-consul, and any person for the time being discharging the duties of consul-general, consul, or vice-consul; the expression "Person" includes a body of persons corporate or unincorporate; the expression "Court" includes any tribunal or magistrate exercising jurisdiction under this act.

29. This act shall come into force on such day as may be fixed by a notice in that behalf published in the London Gazette, which day is in this act referred to as the commencement of this act.

30. (1) After the commencement of this act the acts specified in the first part of the second schedule to this act shall be repealed to the extent specified in the third column of that schedule.

(2) After the commencement of this act the acts specified in the second part of the second schedule to this act shall be repealed to the extent specified in the third column of that schedule:

Provided that, until the date hereinafter mentioned at which such repeal takes full effect, the repeal of the enactments specified in the said second part shall, except within the North Sea, as defined by the first schedule to this act, be subject to the following limitations:

(*a*) The repeal shall not extend to section 12 of the sea fisheries act, 1868 (which section relates to oyster fishing), nor to the recovery of any penalty for a violation of that section.

(b) The repeal shall extend only to officers and boats within the exclusive fishery limits of the British Islands and to British sea-fishing boats when outside the exclusive fishery limits of the British Islands.

(c) The repeal shall not affect the power of French sea-fishery officers and French courts over British sea-fishing boats when outside the exclusive fishery limits of the British Islands, or the power of British and French sea-fishery officers and British courts over French sea-fishing boats brought within the exclusive fishery limits of the British Islands for offenses committed outside those limits.

(d) The repeal shall not alter the power of receiving as evidence any depositions, minutes, and other documents which by the said acts are made receivable as evidence.

(e) If the convention set forth in the first schedule to the sea fisheries act, 1868, comes into operation, then, upon notice thereof being given in the London Gazette, the said enactments shall, subject to the provisions of this section, be in force for the purposes of such convention.

If this act is applied by order in council to French sea-fishery officers and French sea-fishing boats within the seas to which the convention set forth in the first schedule to the sea fisheries act, 1868, applies, the said repeal of the enactments specified in the second part of the second schedule to this act shall take full effect as from the date at which such application of this act takes effect.

(3) The repeal of any enactment by this act shall not affect anything duly done or suffered, or any liability, penalty, forfeiture, or punishment incurred under any enactment hereby repealed, and any legal proceeding or remedy in respect of such liability, penalty, forfeiture, or punishment may be carried on as if this act had not passed.

31. So much of this act as has effect outside of the exclusive fishery limits of the British Islands shall, if the convention ceases to be binding on Her Majesty, cease to apply to the boats and officers of any foreign state bound by the convention, and if the convention ceases to be binding on any foreign state, shall cease to apply to the boats and officers of such state, but subject as aforesaid this act shall continue in force notwithstanding the determination of the convention.

First Schedule.

International convention for the purpose of regulating the police of the fisheries in the North Sea outside territorial waters.

Her Majesty the Queen of the United Kingdom of Great Britain and Ireland; His Majesty the Emperor of Germany, King of Prussia; His Majesty the King of the Belgians; His Majesty the King of Denmark; the President of the French Republic; and His Majesty the King of the Netherlands, having recognized the necessity of regulating the police of the fisheries in the North Sea outside territorial waters, have

resolved to conclude for this purpose a convention, and have named their plenipotentiaries as follows:—

Her Majesty the Queen of the United Kingdom of Great Britain and Ireland: the Hon. William Stuart, Companion of the Most Honorable Order of the Bath, &c., her envoy extraordinary and minister plenipotentiary at the Hague; Charles Malcolm Kennedy, esq., Companion of the Most Honorable Order of the Bath, &c., head of the commercial department of the foreign office; and Charles Cecil Trevor, esq., barrister at law, assistant secretary to the Board of Trade, &c.;

His Majesty the Emperor of Germany, King of Prussia: Veit Richard von Schmidthals, Knight of the Order of the Red Eagle of the third class, and of the Order of St. John, &c., councilor of legation, his chargé d'affaires at the Hague; and Peter Christian Kinch Donner, Knight of the Order of the Red Eagle of the fourth class with the Sword, and of the Crown of the fourth class, &c., his councilor of state, captain in the navy, on the reserve;

His Majesty the King of the Belgians: the Baron d'Anethan, Commander of the Order of Leopold, &c., his envoy extraordinary and minister plenipotentiary at the Hague; and M. Léopold Orban, Commander of the Order of Leopold, &c., his envoy extraordinary and minister plenipotentiary, director-general of the political department in the ministry of foreign affairs;

His Majesty the King of Denmark: Carl Adolph Bruun, Knight of the Order of the Danebrog, &c., captain in the navy;

The President of the French Republic: the Count Lefèbvre de Béhaine, Commander of the National Order of the Legion of Honor, &c., envoy extraordinary and minister plenipotentiary of the French Republic at the Hague; and M. Gustave Émile Mancel, Officer of the National Order of the Legion of Honor, &c., commissary of marine;

His Majesty the King of the Netherlands: the Jonkheer Willem Frederik Rochussen, Commander of the Order of the Lion of the Netherlands, &c., his minister of foreign affairs; and Eduard Nicolaas Rahusen, Knight of the Order of the Lion of the Netherlands, &c., president of the committee for sea fisheries;

Who, after having communicated the one to the other their full powers, found in good and due form, have agreed upon the following articles:—

Article I.

The provisions of the present convention, the object of which is to regulate the police of the fisheries in the North Sea outside territorial waters, shall apply to the subjects of the high contracting parties.

Article II.

The fishermen of each country shall enjoy the exclusive right of fishery within the distance of 3 miles from low-water mark along the

whole extent of the coast of their respective countries, as well as of the dependent islands and banks.

As regards bays, the distance of 3 miles shall be measured from a straight line drawn across the bay, in the part nearest the entrance, at the first point where the width does not exceed 10 miles.

The present article shall not in any way prejudice the freedom of navigation and anchorage in territorial waters accorded to fishing boats, provided they conform to the special police regulations enacted by the powers to whom the shore belongs.

Article III.

The miles mentioned in the preceding article are geographical miles, whereof sixty make a degree of latitude.

Article IV.

For the purpose of applying the provisions of the present convention, the limits of the North Sea shall be fixed as follows:

1. On the north by the parallel of the 61st degree of latitude.

2. On the east and south (1) by the coasts of Norway between the parallel of the 61st degree of latitude and Lindesnaes Light-house (Norway); (2) by a straight line drawn from Lindesnaes Light-house (Norway) to Hanstholm Light-house (Denmark); (3) by the coasts of Denmark, Germany, the Netherlands, Belgium, and France as far as Gris Nez Light-house.

3. On the west, (1) by a straight line drawn from Gris Nez Light-house (France) to the easternmost light-house at South Foreland (England); (2) by the eastern coasts of England and Scotland; (3) by a straight line joining Duncansby Head (Scotland) and the southern point of South Ronaldsha (Orkney Islands); (4) by the eastern coasts of the Orkney Islands; (5) by a straight line joining North Ronaldsha Light-house (Orkney Islands) and Sumburgh Head Light-house (Shetland Islands); (6) by the eastern coasts of the Shetland Islands); (7) by the meridian of North Unst Light-house (Shetland Islands) as far as the parallel of the 61st degree of latitude.

Article V.

The fishing boats of the high contracting parties shall be registered in accordance with the administrative regulations of each country. For each port there shall be a consecutive series of numbers, preceded by one or more initial letters, which shall be specified by the superior competent authority.

Each Government shall draw up a list showing these initial letters. This list, together with all modifications which may subsequently be made in it, shall be notified to the other contracting powers.

Article VI.

Fishing boats shall bear the initial letter or letters of the port to which they belong and the registry number in the series of numbers for that port.

Article VII.

The name of each fishing boat and that of the port to which she belongs shall be painted in white oil color on a black ground on the stern of the boat, in letters which shall be at least 8 centimeters in height and 12 millimeters in breadth.

Article VIII.

The letter or letters and numbers shall be placed on each bow of the boat 8 or 10 centimeters below the gunwale, and so as to be clearly visible. They shall be painted in white oil color on a black ground.

The distance above mentioned shall not, however, be obligatory for boats of small burden, which may not have sufficient space below the gunwale.

For boats of 15 tons burden and upwards the dimensions of the letters and numbers shall be 45 centimeters in height and 6 centimeters in breadth.

For boats of less than 15 tons burden the dimensions shall be 25 centimeters in height and 4 centimeters in breadth.

The same letter or letters and numbers shall also be painted on each side of the mainsail of the boat, immediately above the close reef, in black oil color on white or tanned sails, and in white oil color on black sails.

The letter or letters and numbers on the said sails shall be one-third larger in every way than those placed on the bows of the boat.

Article IX.

Fishing boats may not have, either on their outside or on their sails, any names, letters, or numbers other than those prescribed by Articles VI, VII, and VIII of the present convention.

Article X.

The names, letters, and numbers placed on the boats and on their sails shall not be effaced, altered, made illegible, covered, or concealed in any manner whatsoever.

Article XI.

All the small boats, buoys, principal floats, trawls, grapnels, anchors, and generally all fishing implements shall be marked with the letter or letters and numbers of the boats to which they belong.

These letters and numbers shall be large enough to be easily distinguished. The owners of the nets or other fishing implements may further distinguish them by any private marks they think proper.

ARTICLE XII.

The master of each boat must have with him an official document, issued by the proper authority in his own country, for the purpose of enabling him to establish the nationality of the boat.

This document must always give he letter or letters and number of the boat, as well as her description and the name or names of the owner or the name of the firm or association to which she belongs.

ARTICLE XIII.

The nationality of a boat must not be concealed in any manner whatsoever.

ARTICLE XIV.

No fishing boat shall anchor between sunset and sunrise on grounds where drift-net fishing is actually going on.

This prohibition shall not, however, apply to anchorings which may take place in consequence of accidents or of any other compulsory circumstances.

ARTICLE XV.

Boats arriving on the fishing-grounds shall not either place themselves or shoot their nets in such a way as to injure each other, or as to interfere with fishermen who have already commenced their operations.

ARTICLE XVI.

Whenever, with the view of drift-net fishing, decked boats and undecked boats commence shooting their nets at the same time, the undecked boats shall shoot their nets to windward of the decked boats.

The decked boats, on their part, shall shoot their nets to leeward of the undecked boats.

As a rule, if decked boats shoot their nets to windward of undecked boats which have begun fishing, or if undecked boats shoot their nets to leeward of decked boats which have begun fishing, the responsibility as regards any damages to nets which may result shall rest with the boats which last began fishing, unless they can prove that they were under stress of compulsory circumstances or that the damage was not caused by their fault.

ARTICLE XVII.

No net or any other fishing engine shall be set or anchored on grounds where drift-net fishing is actually going on.

Article XVIII.

No fisherman shall make fast or hold on his boat to the nets, buoys, floats, or any other part of the fishing-tackle of another fisherman.

Article XIX.

When trawl fishermen are in sight of drift-net or of long-line fishermen, they shall take all necessary steps in order to avoid doing injury to the latter. Where damage is caused, the responsibility shall lie on the trawlers, unless they can prove that they were under stress of compulsory circumstances, or that the loss sustained did not result from their fault.

Article XX.

When nets belonging to different fishermen get foul of each other the nets shall not be cut without the consent of both parties.

All responsibility shall cease if the impossibility of disengaging the nets by any other means is proved.

Article XXI.

When a boat fishing with long lines entangles her lines in those of another boat, the person who hauls up the lines shall not cut them except under stress of compulsory circumstances, in which case any line which may be cut shall be immediately joined together again.

Article XXII.

Except in cases of salvage and the cases to which the two preceding articles relate, no fisherman shall, under any pretext whatever, cut, hook, or lift up nets, lines, or other gear not belonging to him.

Article XXIII.

The use of any instrument or engine which serves only to cut or destroy nets is forbidden.

The presence of any such engine on board a boat is also forbidden.

The high contracting parties engage to take the necessary measures for preventing the embarkation of such engines on board fishing boats.

Article XXIV.

Fishing boats shall conform to the general rules respecting lights which have been or may be adopted by mutual arrangement between the high contracting parties with the view of preventing collisions at sea.

Article XXV.

All fishing boats, all their small boats, all rigging gear or other appurtenances of fishing boats, all nets, lines, buoys, floats, or other fishing implements whatsoever found or picked up at sea, whether marked

or unmarked, shall as soon as possible be delivered to the competent authority of the first port to which the salving boat returns or puts in.

Such authority shall inform the consul or consular agent of the country to which the boat of the salvor belongs, and of the nation of the owner of the articles found. They (the same authority) shall restore the articles to the owners thereof or to their representatives as soon as such articles are claimed and the interests of the salvors have been properly guaranteed.

The administrative or judicial authorities, according as the laws of the different countries may provide, shall fix the amount which the owners shall pay to the salvors.

It is, however, agreed that this provision shall not in any way prejudice such conventions respecting this matter as are already in force, and that the high contracting parties reserve the right of regulating, by special arrangements between themselves, the amount of salvage at a fixed rate per net salved.

Fishing implements of any kind found unmarked shall be treated as wreck.

ARTICLE XXVI.

The superintendence of the fisheries shall be exercised by vessels belonging to the national navies of the high contracting parties. In the case of Belgium, such vessels may be vessels belonging to the state, commanded by captains who hold commissions.

ARTICLE XXVII.

The execution of the regulations respecting the document establishing nationality, the marking and numbering of boats, &c., and of fishing implements, as well as the presence on board of instruments which are forbidden (Articles VI, VII, VIII, IX, X, XI, XII, XIII, and XXIII, section 2), is placed under the exclusive superintendence of the cruisers of the nation of each fishing boat.

Nevertheless, the commanders of cruisers shall acquaint each other with any infractions of the above-mentioned regulations committed by the fishermen of another nation.

ARTICLE XXVIII.

The cruisers of all the high contracting parties shall be competent to authenticate all infractions of the regulations prescribed by the present convention, other than those referred to in Article XXVII, and all offenses relating to fishing operations, whichever may be the nation to which the fishermen guilty of such infractions may belong.

ARTICLE XXIX.

When the commanders of cruisers have reason to believe that an infraction of the provisions of the present convention has been committed,

they may require the master of the boat inculpated to exhibit the official document establishing her nationality. The fact of such document having been exhibited shall then be indorsed upon it immediately.

The commanders of cruisers shall not pursue further their visit or search on board a fishing boat which is not of their own nationality, unless it should be necessary for the purpose of obtaining proof of an offense or of a contravention of regulations respecting the police of the fisheries.

ARTICLE XXX.

The commanders of the cruisers of the signatory powers shall exercise their judgment as to the gravity of facts brought to their knowledge, and of which they are empowered to take cognizance, and shall verify the damage, from whatever cause arising, which may be sustained by fishing boats of the nationalities of the high contracting parties.

They shall draw up, if there is occasion for it, a formal statement of the verification of the facts as elicited both from the declarations of the parties interested and from the testimony of those present.

The commander of the cruiser may, if the case appears to him sufficiently serious to justify the step, take the offending boat into a port of the nation to which the fishermen belong. He may even take on board the cruiser a part of the crew of the fishing boat, in order to hand them over to the authorities of her nation.

ARTICLE XXXI.

The formal statement referred to in the preceding article shall be drawn up in the language of the commander of the cruiser, and according to the forms in use in his country.

The accused and the witnesses shall be entitled to add, or to have added, to such statement, in their own language, any observations or evidence which they may think suitable. Such declarations must be duly signed.

ARTICLE XXXII.

Resistance to the directions of commanders of cruisers charged with the police of the fisheries, or of those who act under their orders, shall, without taking into account the nationality of the cruiser, be considered as resistance to the authority of the nation of the fishing boat.

ARTICLE XXXIII.

When the act alleged is not of a serious character, but has nevertheless caused damage to any fisherman, the commanders of cruisers shall be at liberty, should the parties concerned agree to it, to arbitrate at sea between them, and to fix the compensation to be paid.

Where one of the parties is not in a position to settle the matter at once, the commanders shall cause the parties concerned to sign in duplicate a formal document specifying the compensation to be paid.

One copy of this document shall remain on board the cruiser, and the other shall be handed to the master of the boat to which the compensation is due, in order that he may, if necessary, be able to make use of it before the courts of the country to which the debtor belongs.

Where, on the contrary, the parties do not consent to arbitration, the commanders shall act in accordance with the provisions of Article XXX.

ARTICLE XXXIV.

The prosecutions for offenses against or contraventions of the present convention shall be instituted by or in the name of the state.

ARTICLE XXXV.

The high contracting parties engage to propose to their respective legislatures the necessary measures for insuring the execution of the present convention, and particularly for the punishment by either fine or imprisonment, or by both, of persons who may contravene the provisions of Articles VI to XXIII, inclusive.

ARTICLE XXXVI.

In all cases of assault committed or of wilful damage or loss inflicted by fishermen of one of the contracting countries upon fishermen of another nationality, the courts of the country to which the boats of the offenders belong shall be empowered to try them.

The same rule shall apply with regard to offenses against and contraventions of the present convention.

ARTICLE XXXVII.

The proceedings and trial in cases of infraction of the provisions of the present convention shall take place as summarily as the laws and regulations in force will permit.

ARTICLE XXXVIII.

The present convention shall be ratified. The ratifications shall be exchanged at the Hague as soon as possible.

ARTICLE XXXIX.

The present convention shall be brought into force from and after a day to be agreed upon by the high contracting yarties.

The convention shall continue in operation for five years from the above day; and, unless one of the high contracting parties shall, twelve months before the expiration of the said period of five years, give notice of intention to terminate its operation, shall continue in force one year longer, and so on from year to year. If, however, one of the signatory powers should give notice to terminate the convention, the same shall be maintained between the other contracting parties, unless they give a similar notice.

ADDITIONAL ARTICLE.

The Government of His Majesty the King of Sweden and Norway may adhere to the present convention, for Sweden and for Norway, either jointly or separately.

This adhesion shall be notified to the Netherlands Government, and by it to the other signatory powers.

In witness whereof the plenipotentiaries have signed the present convention, and have affixed thereto their seals.

Done at the Hague, in six copies, the 6th May, 1882.

W. STUART. LÉOPOLD ORBAN.
C. M. KENNEDY. C. BRUUN.
C. CECIL TREVOR. Cte LEFÈBVRE DE BÉHAINE.
V. SCHMIDTHALS. EM. MANCEL.
CHR. DONNER. ROCHUSSEN.
Bon A. D'ANETHAN. E. N. RAHUSEN.

SECOND SCHEDULE.

ENACTMENTS REPEALED.

A description or citation of an act in this schedule is inclusive of the word, section, or other part first and last mentioned, or otherwise referred to as forming the beginning or as forming the end of the portion described in the description or citation.

PART I.—*Enactments wholly repealed.*

Session and chapter.	Title.	Extent of repeal.
6 and 7 Vict., c. 79.	An act to carry into effect a convention between Her Majesty and the King of the French concerning the fisheries in the seas between the British Islands and France.	So much of the schedule thereto as prohibits any French fishing-boat from approaching nearer to any part of the coast of the United Kingdom than the limit of 3 miles, and so much of the rest of the act as relates to the portion of the schedule hereby repealed.
31 and 32 Vict., c. 45.	The sea fisheries act, 1868	Section 25; Section 58, from "in manner directed by law" to "the appeal shall be made," and from "for the county or place" to "costs to be paid by either party"; Section 71 and the second schedule.
40 and 41 Vict., c. 42.	The fisheries (oyster, crab, and lobster) act, 1877.	Section 15.

PART II.—*Enactments repealed provisionally.*

31 and 32 Vict., c. 45.	The sea fisheries act, 1868	Sections 3 and 4; Section 5, from "the term consular officer" to "construed to mean consular officer"; Section 6 to 16; Sections 20 and 21; Section 59; Section 61; Section 63, from the beginning of the section to "the satisfaction of the court"; The first schedule, except articles 4 to 8, article 31, and the declaration and list of ports annexed to the convention.
38 Vict., c. 15	An act to amend the sea fisheries act, 1868.	Section 3.

APPENDIX B.

THE FISHERIES.

V.—THE PRINCIPAL RIVER FISHERIES OF THE UNITED STATES, WITH AN ESTIMATE OF THE CATCH FOR 1880.

By Chas. W. Smiley.

Principal and tributary waters.	Annual catch.
MAINE.	*Pounds.*
Saint John River	20,000
Saint Croix River, Schoodic Lake and tributaries	45,000
Denny's River	50,000
Cobscook River	25,000
Machias and East Machias Rivers	125,000
Tunk, Narragaugus, Harrington, Pleasant, Indian, and Chandler's Rivers	135,000
Union River	25,000
Penobscot River: Gray's or Walker's Pond, Alamoosook, Toddy, Craig, and other ponds, Pushaw River, Passadumkeag River, Piscataquis, Pleasant, Sebec River and ponds, Mattawamkeag and Salmon Rivers	700,000
Pemaquid, Muscongus, Saint George Rivers, &c	450,000
Damariscotta River	1,500,000
Sheepscott River	50,000
Kennebec River: Androscoggin River, Little Androscoggin River and Thompson Lake, Weld Pond, Ellis and Bear Branch, Umbagog, Richardson, Molechunkemunk River, Moostocmaguntic, Rangeley, and other lakes, Eastern River, Cobbossecontee River and Lake, Sebasticook River, Messalonskee River and Belgrade Lake, Wisserunset, Sandy, Carrabasset, and Dead Rivers, Moosehead Lake, Moose River	1,290,000
Presumpscot River: Sebago, Long Lake, &c., Songo River, Crooked River	18,000
Saco River, Little Ossipee River	16,500
Mousam River	10,000
York River	5,000
Piscataquis River	85,000
VERMONT.	
Lake Memphremagog, Black River, and Barton River	65,500
Lake Champlain: Lamoille River, Winooski or Onion River, Otter Creek, Poultney River, Pawlet River, Lake George, Boquet River, Au Sable River, Chazy River, Saranac River and Lake	1,272,000
MASSACHUSETTS.	
Merrimac River: Concord, Sudbury, and Assabet Rivers, Nashua River, Contoocook River, Pemigewasset River, Winnipiseogee Lake and River	400,000

Principal and tributary waters.	Annual catch.
MASSACHUSETTS—Continued.	*Pounds.*
Parker and Ipswich Rivers, and Wenham Pond	8,000
Essex River, Chebacco Pond, North, South, and Saugus Rivers	100,000
Mystic, Charles, and Neponset Rivers	175,000
Fore, Back, North, South, and Jones Rivers	220,000
Great South Pond	50,000
Streams, &c., of Barnstable and Dukes Counties	800,000
Wareham and Half-way Ponds, Weweautitt, Mattapoisett, Sippican, Acushnet, Apponegansett, Pamanset, and Westport Rivers	875,000
Taunton River: Nomasket River and Winetuxet River	860,000
Palmer River	10,000
RHODE ISLAND.	
Wallum Lake	3,000
Sakonnet River	450,000
Warren River	40,000
Providence River: Pawtucket River, Blackstone River	353,000
Powtowomut and Pawtuxet Rivers	55,000
Coast ponds and Pettaquamsutt River	65,000
Pawcatuck River	45,000
CONNECTICUT.	
Mystic River	9,000
Thames River: Quinebaugh River, Shetucket River, Moosup River	29,500
Connecticut River: Farmington River, Agawam, Little, and Westfield Rivers; Chicopee, Ware, and Swift Rivers; Deerfield and Miller's Rivers; Ashuelot River, West River, Sugar River, Ammonoosuc River, and Indian Stream	842,300
Branford River	150
Quinnipiac River	2,500
Housatonic River: Naugatuck River, Shepaug River	230,000
Saugatuck River	1,500
Norwalk River	6,000
Mianus and Mill Rivers	250
NEW YORK.	
Hudson River: Croton River and Lake, Dutchess and Columbia County streams and lakes, Rondout and Walkill Rivers, Esopus Creek, Catskill Creek, Kinderhook Creek and Lake, Mohawk River, Schoharie River, West Canada	

Principal and tributary waters.	Annual catch.
NEW YORK—Continued.	*Pounds.*
Hudson River—Continued. Creek, Fish Creek and Saratoga Lake, Battenkill Creek and Lake, Sacondaga River, Schroon River and Lake, Indian River and Lake, Jessup's, Boreas and Cedar Rivers, Delia and Sanford Lakes	3,300,000
Saint Lawrence River: Chateaugay River and Lake, Trout and Salmon Rivers, Saint Regis, Racket, and Grass Rivers, Oswegatchie River, Black Lake, Cranberry Lake	1,100,000
Greenwood, Rockland, Cedar, and other Lakes	45,000
Byram River	3,000
Long Island streams and ponds	210,000
The canals	30,000
Princess Bay	
Rockaway and Jamaica Bays	
Great South Bay, &c	
Great Peconic Bay, &c	
Oyster Bay, &c	
NEW JERSEY.	
Hopatcong, Budd's, Green, Split, Rock Lakes, &c	140,000
Hackensack River	250,000
Passaic River	125,000
Raritan River, South River, Neshanic River	285,000
Shrewsbury River	350,000
Shark River	80,000
Barnegat Bay: Tonis and Metedeconk Rivers	300,000
Mullicus, or Little Egg Harbor River, Bass, and Wading Rivers	345,000
Great Egg Harbor River	120,000
Tuckahoe River	45,000
West, East, and Dennis Creeks	95,000
Maurice River; Lebanon and Muddy Creeks	290,000
Delaware River: Cohansey Creek, Stow, Alloways, Salem, Old Man's, Mantua, Cooper, and Crosswicks Creeks, Rancocas Creek, Musconetcong, Pequest, Paulinskill Rivers, and Schwartswood Lake, Christiana Creek, Brandywine Creek, Schuylkill River, Neshaminy Creek, Great and Little Lehigh Rivers, Hockendauga Creek, Lackawaxen River, Walen Paupac Creek, Long, Keene, Elk, White Oak, Maple, and other ponds, Neversink, Beaverkill Rivers, Ponds, &c	8,525,000
DELAWARE.	
Mahon River	7,000
Saint Jones Creek	729,000
Murderkill Creek	32,000
Mispillion and Cedar Creeks	110,000
Broad Kill Creek	22,000
Indian River	310,000
Creeks in Accomac and Northampton Counties of Virginia	950,000
MARYLAND.*	
Pocomoke, Annemessex, Manokin, and Wicomico Rivers	650,000
Nanticoke River	400,000
Blackwater and Transquaking Rivers	15,000
Houga River	5,000
Little Choptank River	5,000

Principal and tributary waters.	Annual catch.
MARYLAND—Continued.	*Pounds.*
Choptank River	1,000,000
Broad and Harris Creeks	10,000
Wye and Saint Michael's Rivers	20,000
Chester River	50,000
Sassafras River	45,000
Elk River	50,000
Northeast River	75,000
Susquehanna River: Big and Little Conewago Creeks, Conestoga, Cocalico, and Chieques Creek, Conodoquinet and Sherman Creeks, Juniata River, Rayston Creek, Middle and Penn's Creeks, and Gravel Run, Muncy, Loyalsock, Lycoming, Pine, and Babb's Creeks, Fishing, Bald Eagle, and Beech Creeks, Sinnemahoning River, Young Woman, Paddy, Kettle, East Branch, and Portage Creeks, Moshannon, Clearfield, and Chest Creeks, Columbia, Luzerne, and Lackawanna County tributaries, Harvey's Lake, Mekoopany, Tunkhannock, Martin, Hop Bottom, and Meshoppen Creeks, and Carey's, Oxbow, and Elk Lakes, Towanda, and Sugar Creeks, Chemung River, Tioga, Canisteo, and Conhocton Rivers, Lamoka and Oneta (Wauneta) Lakes, Cayuta Creek, Chenango River, Tioughnioga and Otsetic Rivers, Unadilla River, Otego and Charlotte Creeks, Otsego, and Schuyler's (Canaderaga) Lakes	2,000,000
Bush River	50,000
Gunpowder River	100,000
Middle and Back Rivers	50,000
Patapsco River	200,000
Magothy River	25,000
Severn River	25,000
South River	10,000
Rhode River	5,000
West River	10,000
Patuxent River	800,000
Potomac River: Wicomico River, Monocacy River, rivers and creeks of Northumberland and Westmoreland Counties, Aquia, Chopawamsic, and Quantico Creeks, Occoquan River, Goose Creek, Shenandoah River, Cedar Creek, South, Christians, and Middle Forks, Opequon Creek, Conococheaque, Licking, Conotowas, Town, and Wills Creeks	6,000,000
VIRGINIA.	
Rappahannock River, Rapidan River	1,500,000
Piankatank River	350,000
East, North, Ware, and Severn Rivers	250,000
York River: Mattapony River, Pamunkey River, North and South Anna Rivers	1,800,000
Back River	270,000
James River: Hampton, Elizabeth, and Nansemond Rivers, and Pagan Creek, Chickahominy River, Appomattox River, Willis, Rivannah, Slate, and Hardware Rivers, North River, Catawba and Craig Creeks, Cow Pasture and Jackson Rivers	3,750,000
Lynhaven River	200,000
Lake Drummond	10,000

* This is the State where the waters of the streams named under it reach the ocean, though the streams themselves may flow through other States.

Principal and tributary waters.	Annual catch.
NORTH CAROLINA.	*Pounds.*
North River	65,000
Pasquotank River	
Perquimans River	
Chowan River, Meherrin, Nottaway, and Blackwater Rivers	375,000
Roanoke River: Cashie River, Staunton River, Otto, and Blackwater Rivers, Dan River, Hycottee, Banister, and Smiths Rivers	560,000
Scuppernong River	
Pamlico River, Pungo River	490,000
Bay River	35,000
Neuse River, Trent River, Contentnea Creek, Eno, Little and Flat Rivers	350,000
Newport River	225,000
White Oak River	2,220,000
New River	700,000
Cape Fear River: Northeast Cape Fear River, South River, Black River, Upper and Lower Little Rivers, Deep River, Haw River	1,289,300
Logwood Folly River	40,000
SOUTH CAROLINA.	
Winyah Bay: Waccamaw River, Waccamaw Lake, Great Pee Dee River, Little Pee Dee River, Lumber River, Lynche's Creek, Crooked Creek, Iredell and Yadkin Counties (N. C.) creeks and ponds, Black River	820,000
Santee River: Wateree River, (Catawba, in North Carolina), John's River, Congaree River, Saluda River, Broad River, Enoree, and Tiger Rivers	452,500
Ashley and Cooper Rivers	25,000
Edisto River, Four-Hole Creek	267,500
Ashepoo River	50,000
Combahee River	25,000
Coosawhatchie River	450,000
Savannah River: Briar and McBean Creeks, Horse and Big Spencer Creeks, and Langley and other mill ponds, Tugaloo River, Broad River, Tallulah and Chatuga Rivers, Keowee River	1,072,500
GEORGIA.	
Ogeechee River, Cannouchee River	400,000
North and South Newport and Sapelo Rivers	375,000
Altamaha River: Great Ohoopee River, Oconee River, Turkey, Appalachee and Mulberry Creeks, Ocmulgee River, Swamp and Sugar Creeks, South and Yellow Rivers, Alcora, Willow and Murder Creeks	500,000
Great and Little Satilla Rivers	380,000
Saint Mary's River	275,000
FLORIDA.	
Saint John's River: Lake Crescent and Deep River, Ocklawaha River, Orange River and Lake, Lake Griffin, Lake Eustis, Lake Ocklawaha, Lake Apopka, Lake Kingsley, Lake George, Lake Monroe, Lake Jessup, Lakes Weekiva, Maitland, Norris, and Yale, Lake Conway, Lake Poinsett	500,000
Matanzas River	5,000
Halifax and Hillsboro Rivers	10,000
Indian River	50,000
Caloosahatchie River	15,000
FLORIDA—Continued.	
Charlotte Harbor, Pease Creek	25,000
Sarasota Bay	10,000
Tampa Bay, Manatee River, Hillsboro Bay and River, Alafia River	15,000
Boca Diego Bay	5,000
Clear Water Harbor	5,000
Anclote and Echaskotee Rivers	20,000
Chesschowiska and Homosassa Rivers	10,000
Crystal River	5,000
Withlocoochee River	20,000
Wacasassa River	15,000
Suwannee River: Santa Fe River, Sampsen and Butler Lakes, Pithlacoochee, Santa Fé, and other lakes, Allapaha River, Withlacoochee and Little Rivers, Pisacola, Ocopilco, Ty Ty, and Warrior Creeks	100,000
Steinhatchee River	5,000
Ocilla and Wacissa Rivers	10,000
Saint Mark's River and Miccosukee Lake	25,000
Ocklockonee River	25,000
Appalachicola River: Chipola River, Chattahoochee River, Flint River, Natcheway and Pachitta Creeks, Kinahafoonee, Muckhall, Buck, Cedar, Camp, and White Oak Creeks, Osahatchee, Big Dover, Sugar, Tesantee, and Chestatee Creeks	300,000
Saint Andrew's Bay	5,000
Choctawhatchee River, Pea River	20,000
Yellow and Blackwater Rivers	20,000
Escambia River, Conecuh River	20,000
Perdido Bay and River	5,000
ALABAMA.	
Bon Secour, Fish, and Tensaw Rivers	165,000
Mobile River: Lesser tributaries of the Mobile River, Tombigbee River, Sucarnochee and Alamuchie Rivers, Tuscaloosa River, Coal Fire and Sipsey Rivers, Buttahatchee, Looxapalila, Noxubee, and Tibbee Rivers, Alabama River Cahawba River, Coosa River, Hatchett, Paint, Peckerwood, Kelley, Wolf, Tallassechatchee, Yellow Leaf and Talladega Creeks, Cheekcleeke, Shoal, Cane, and Tallasee Creeks, Ohatchie, Wills, Chatooga, Cedar, and Little Creeks, Etowah River, Coosawattee River, Connasauga and Cooahulla Rivers, Ellijay and Carticay Rivers, Tallapoosa River	1,418,000
Bayou la Batre	85,000
MISSISSIPPI AND LOUISIANA.	
Pascagoula River: Leaf River, Bogue Homo and Tallahala Creek, Ohatoma and Oakohay Creeks, Chickasawha River	[illegible]65,000
Old Forte Bayou	10,000
Biloxi River	12,000
Wolf River	10,000
Pearl River: Bogue Chitto, Silver Creek, Strong River, Yockanookany River	[illegible]10,000
Lakes Ponchartrain and Borgne, Lake Maurepas, Amite River, Tangipohoa River	[illegible]110,000
Little Lake and River Aux Chenes	5,000
Bayous and bays near New Orleans	95,000

Principal and tributary waters.	Annual catch.
MISSISSIPPI RIVER SYSTEM.	*Pounds.*
Red River (tributary of Mississippi River): Black or Washita River, Tensas River, Bayou Bartholomew, Bayou d'Arbonne, Saline River, Eagle Creek, Bayous Moro and Champagnolle, Little Missouri River, Caddo Creek, Badeau and Dorcheat Bayous, Caddo Lake, Little and Big Cypress Rivers, Sulphur Fork, Little and Saline Rivers, Boggy River, Blue River, Little Wichita and Big Wichita Rivers...	2,020,000
Yazoo River (tributary of Mississippi River): Sunflower River, Deer Creek, Yalabusha River, Shooner River, Tapashaw Creek, Cold Water River, Tallahatchie River, Yocona River, Yazoo Pass, Horn Lake......	615,000
Arkansas River (tributary of Mississippi River): Bayou Meta, Palarm Creek, Fourche la Fave Creek, Point Remove Creek, Peitit Jean Creek, Illinois, Piney, and Mulberry Creeks, Poteau River, Canadian River, Deep Fork of Canadian River, Gains Creek, Illinois River, Osage Creek, Neosho or Grand River, Elk River, Spring River, Shoal and Cow Creeks, Labette, Gooseberry, Big and Little Walnut, Owl, Crooked and Turkey Creeks, Cottonwood Creek, Marle and Muddy Creeks, Verdigris River, Big Caney and North Caney Rivers, Pumpkin, Elk, and Fall Rivers, Bear Creek, Cimarron, Nescutunga, Medicine Lodge, Bluff, and Chikaskia Rivers, Walnut, White Water, and Hickory Creeks, Slate Creek, and Ninnescah River, Little Arkansas River, Cow and Rattlesnake Creeks, Walnut and Pawnee Creeks, Mulberry Creek, Purgatorio or Las Animas River, Huerfano River, St. Charles Creek, Grape Creek.................	1,591,000
White River (tributary of Mississippi River): La Grue River, Big Creek, Cypress Bayou, and Holloway Lake, Cache River, Little Red River, Black River, Strawberry River, Spring River, Eleven Points River, Current River, Buffalo Fork and Crooked Creek, War Eagle Creek................................	723,000
Ohio River (tributary of Mississippi River): Cache River and Lakes, Humphreys and Massoc Creeks, Tennessee River, Clarks, Bonds, and Blood Creeks, Big Sandy River, White Oak Creek, Duck River, Buffalo Creek, Piney, Swan, Lick, Carter's, and Little Creeks, Beech, Indian, Shoal, and Sugar Creeks, Yellow and Big Bear Creeks, Elk River, Richland Creek, Sequatchie River, Chattanooga, Chickamauga, and Oconee Creeks, Hiawassee River, Clinch River, Emory River, Poplar, Beaver, Cove, and Indian Creeks, Powell's River, Walden Creek, Little Tennessee River, Little River, Tuckasegee River, Oconaluftee River, Nantahala River, Holston River, Watauga River, French Broad River, Pigeon and Great Pigeon Rivers, Nolanchucky River, North and South Toe River, Cumberland River, Little and Red Rivers, Harpeth River,	

Principal and tributary waters.	Annual catch.
MISS. RIVER SYSTEM—Cont'd.	*Pounds.*
Ohio River—Continued. Stone River, Caney Fork, Obey's River, Narrowbone, Crocus, Beaver, and Otter Rivers, New and Clear Fork, Rockcastle River, Tradewater River, Saline River, Wabash River, Little Wabash River, Skillet Fork, Patoka River, White River, East Fork of White River, Lost Creek, Indian and Salt Creeks, Muscatatuc and Graham Creeks, Sand Creek, Big and Little Flat Rock, Haw, Clifty, and Sugar Creeks and Blue River, West Fork of White River, Eel River, Deer Creek, Bean, Blossom, White Lick, Eagle, and Fall Creeks, Embarras River, Sugar and Brullet Creeks, and Vermillion River, Raccoon, Sugar, and Coal Creeks, Pine Creek, Wild Cat Creek, Tippecanoe River, Manitau, Pike, and other lakes, Mud Creek, Eel River, Mississineau and Salamonia Rivers, Green River, Pond River, Rough and Caney Creeks, Muddy and Clifty Rivers, Barren River, Casper River, Beaver Creek, Drakes Fork, Rays Fork, Nolin Creek, Little Barren River, Russell's Creek, Otter Creek, Little Pigeon, Anderson's and Indian Creeks, and Little and Great Blue Rivers, Salt River, Rolling Fork, Beach and Chaplins' Creeks, Floyd's Fork, Kentucky River, Eagle Creek, Elkhorn Creek, Dick's River, Hickman, Paint Lick, and Silver Creeks, Red River, Red Bird Creek, Carr's Fork, Loughery Creek, Great Miami River, White Water River, Licking River, Little Miami River, Scioto River, Salt and Pigeon Creeks, Paint, Clear, Rattlesnake, Buckskin, Deer, and Darby Creeks, Tygart's Creek, Little Sandy River, Big Sandy River, Russell and Louisa Forks, Dry Fork, Tug River, Guyandotte River, Raccoon Creek, Great Kanawha River, Coal River, Elk River, Meadow River, Greenbrier River, Gauley River, New River, Walker's Creek and Little River, Hocking River, Little Kanawha River, Muskingum River, Licking River, Wapetomica, Sims and Wills Creeks, Walhonding River, Tuscarawas River, Duck Creek, Little Muskingum River, Middle Island Creek, Ten Mile, Raccoon, and Buffalo Creeks, Little and Big Beaver Rivers, Conoquenessing, Slippery Rock, Neshannock, and Shenango Creeks, Mahoning River, Monongahela River, Youghiogheny River, Indian and Laurel Hill Creeks, and Castleman's River, Redstone and Ten Mile Creeks, Dunkard's Creek, and Cheat River, Tygert's Valley River, Allegheny River, Kiskiminitas and Conemaugh Rivers, Beaver Run and Loyalhanna Creek, Two Lick and Stone Creeks, Crooked, Mahoning, and Red Bank Creeks, Clarion River, Beaver Mill, and Cooper's Creeks, Venango River, Sugar and Cassewayo Creeks, Findley's Lake, Oil, Caldwell, and Tionesta Creeks, Conewango River, Chautauqua Lake, Cassadaga Lake...	9,226,000

Principal and tributary waters.	Annual catch.
MISS. RIVER SYSTEM—Cont'd.	Pounds.
Missouri River (tributary of Mississippi River): Gasconade River, Osage River, Pomme de Terre River, Sac River, Marmaton and Little Osage Rivers, Big and Little Sugar, Middle, Bull, Wea, and Ottawa Creeks, Dragon, Rock, and Elm Creeks, Moreau and Moniteau Rivers, Lamine River, Chariton River, Grand River, Kansas River, Stranger Creek, Wakarusa River, Grasshopper River, (or Delaware River), Soldier, Mission, Cross, Mill, Vermillion and Rock Creeks, Big Blue River, Vermillion Creek, Little Blue River, Republican River, Buffalo and Beaver Creeks, Buffalo and White Rock Creeks, Smoky Hill River, Solomon River, Bow Creek, Saline River, Gypsum, Big, Lyon's, Chapman's and Camp Creeks, Platte River, Independence Creek, Nodaway River, Wolf Creek, and Great and Little Nemaha Rivers, Tarkio River, Nishnebotene River, Walnut Creek, Keg Creek, Platte River, Elkhorn River, Loup Fork River, North Platte River, Laramie River, Medicine Bow River, South Platte River, Cache la Poudre Creek, Big Thompson Creek, Bear Creek, Mosquito and Pigeon Creeks, Boyer River, and Wall Lake, Soldier River, Little Sioux River, Maple River, Trumball and Lost Island Lakes, Okoboji, Spirit, and Silver Lakes, Floyd River, Big Sioux River, Rock River, Little Rock River, Lake Kampeska, Vermillion River, James River (or Dakota River), Niobrara River White River, North Fork of Cheyenne River (or Belle Fourche River), South Fork of Cheyenne River, Yellowstone River, Powder River, Big Horn River, Wind River, Popo Agie River, Milk River	4,421,000
Illinois River (tributary of Mississippi River); Macoupin, Apple, and Crooked Creeks, Sangamon River, Spoon River, Copperas, Kickapoo, and Mackinaw Creeks, Thompson and Spring Lakes Peoria Lake, Snachwine Lake, Vermillion River, Fox, Pistaqua, Nippersink, and Grass Lakes, Nippersink Creek, White and Honey Rivers, and lakes of Walworth County, Wisconsin, Kankakee River, Iroquis River, Cedar Lake, Du Page, and Des Plaines Rivers	1,040,000
Minnesota River (tributary of Mississippi River); Blue Earth, Naple, Cobb, and Watonwan Rivers, and lakes of Blue Earth and other counties, Swan, Timber, &c., lakes, Big Cottonwood River and lakes, Redwood River and lakes, Yellow Medicine River, Chetomca and Chippewa Rivers, Lac-qui-Parle River, Pomme de Terre River, Big Stone Lake ...	884,000
Mississippi River and smaller tributaries; Homochitto River, Big Black River, Saint Francis River, L'Anguille River, Tyronza River, Little River, Nonconnah, Wolf and Loosahatchie Rivers, Big Hatchie River, Tuscumbia River, Forked Deer and Obion Rivers, Reelfoot Lake, Bayou du Chien Creek, Little Obion and Mayfield Rivers, Big Muddy River, Beaucoup Creek, and Little Muddy River, Union and Jackson County lakes, Kaskaskia River, Kid, Corner, Raynor, Bond, and Long Lakes, Meramec River, Big River, Bourbeuse River, Saint Mary's, Cahokia, and Piasa Creeks, Cuivre River, Salt River, Bay, Kiset, Sug, and Bear Creeks, North and Fabius Rivers, Lima Lake, Des Moines River, Middle River and Clanton's Creek, Raccoon River, Lake Creek and twin Lakes, Storm Lake, Boone River, Lizzard River, Jack Creek, and Swan Lake, Okamanpadu Lake, Skunk River, Cedar Creek, Henderson, Pope, Edwards, and Eliza Creeks, Flint River, Iowa River, Cedar River, Prairie Creek, Otter Creek, Big or Wolf Creek, Black Hawk Creek, Beaver Creek, Shell Rock Creek, Lime Creek, Clear Lake, English River, Salt Creek, Rock River, Green, Elkhorn, and Pine Creeks, and Kishwaukee and Pecatonica Rivers, Catfish River and Dane County lakes, Jefferson County lakes, Dodge County lakes, Waukesha County lakes, Wapsipinicon River, Mud Creek, Buffalo Creek, Plum, Big rush, and Apple Rivers, Maquoketa River, Catfish Creek, Platte and Grant Rivers, Turkey River, Volga River, Wisconsin River, Kickapoo and Pine Rivers, Baraboo and Lemonwear Rivers, Yellow and Eau Pleine Rivers, Rib Rivers, Taylor County lakes, Yellow River, Upper Iowa River, Raccoon River, La Crosse River, Black River, Trempealeau River, Root River, Zumbro River, Buffalo and Eagle Rivers, Chippewa River, Hay and Red Cedar Rivers, Barron County lakes, Chippewa County Lakes, Flambeau River, Cannon River and lakes, Vermillion River, Saint Croix River, Willow, Apple, Trade, Clam, Yellow, and Namekagon Rivers, Polk County lakes, Burnett County lakes, Minnehaha Creek and Minnetonka Lake, Rum River, Elk River, Mille Lacs, &c., Crow River and lakes, Pelican Lake and Clear Water Creek and Lake, Sauk River and lakes, Little Rock, Platte, Spunk, Two, Swan, and Elk Rivers, Crow Wing, Prairie and Leaf Rivers, White Fish, Leech, Cass, Winnibigoshish, and other Lakes	16,304,000
LOUISIANA AND TEXAS.	
Barataria Bay	100,000
Timbalier Bay, La Fourche Bayou	[illegible]
Caillou Bay	[illegible]
Atchafalaya River	[illegible]
Vermillion River	[illegible]
Mermenton River	[illegible]
Calcasieu River	[illegible]
Sabine River, Neches River, Pine Island, Bayou and Village Creeks, Angelina River and Attoyac Creek	[illegible]
Trinity River, Richland, Pecan and Chambers's Creeks, Elm and Denton's Forks	[illegible]

Principal and tributary waters.	Annual catch.
LA. AND TEXAS—Continued.	*Pounds.*
Cedar Bayou	10,000
San Jacinto River; Buffalo Bayou	135,000
Oyster Bayou	10,000
Brazos River; Navasota River, Yegua River, Little Brazos River, Little, Leon, and Lampasas Rivers, Elm Fork, Bosque River, Noland's, Patuxy, Kickapoo, Palo Pinto, and Keochi Creeks	775,000
Caney, Linville, and San Bernard Creeks	30,000
Colorado River: Cumming's Creek, Pedernales River, Llano and San Saba Rivers, Brady's and Pecan Creeks, and Concho River	400,000
Caranchua and Trespalacios Creeks	25,000
Lavaca and Navidad Rivers	60,000
San Antonio and Medina Rivers; Guadalupe River, Sandies Creek, San Marcos River, Plum Creek, and Blanco River, Gibolo Creek	225,000
Aransas and Mission Rivers, and Medio and Copano Creeks	40,000
Nueces River; Rio Frio	45,000
Rio Grande; Rio Pecos, Conejos River; Saguacha River	238,000
Colorado River; Gila River, Salt River, Rio Verde, White Mountain River, San Pedro River, San Francisco River, Little Colorado River, San Juan River, Rio de las Animas, Rio de los Pinos, Fremont Lake, Grand River, Rio Dolores, Rio San Miguel, Gunnison River, Uncompahgre River, Lake Fork, Tamicki Creek, Blue River, Green River, Fish Lake, Ferron's Creek, Bear or Yampah River, Henry's Fork, Muddy Creek	151,750
CALIFORNIA.	
San Diego, Santa Margarita, and Santa Ana Rivers	12,000
San Gabriel, San Buenaventura, and Ynez Rivers	15,000
Santa Rosa, San Simeon, and Arroyo del Final Rivers	9,000
Carmel River	7,000
Monterey Bay: Salinas River, Naciemiento and San Antonio Rivers	150,000
Pajaro River	8,000
Purissima Creek	20,000
San Francisco Bay: Napa and Petaluma Creeks	175,000
Sacramento River: San Joaquin River, Calaveras River, and French Camp Slough, Stanislaus River, Tuolumne River, Merced River, Kings River, Tulare Lake, Tule and Kern River, Mokelumne River, Consumnes River, American River, Silver, Blue, and Caples Lakes, Cache Creek, Bartlett's Creek, Clear Lake, Feather River, Bear Creek, Yuba River, Stony, Mill, Deer, and other Creeks, Pitt River, Cow Creek, McCloud River, Goose Lake, &c	12,100,000
Russian River	300,000
Gualala River	125,000
Garcia River	80,000
Navarro and Big Rivers	180,000
Ten Mile Creek	45,000
Eel River: Van Dusen's, Dobbin's, Connolly's, Larrabee's and Smith's Fork	600,000
Humboldt Bay: Elk River	25,000
Mad River	100,000
Klamath River: Trinity River, Salmon and Shasta Rivers, Lost River, and Tule Lake	833,000
Smith River	400,000

Principal and tributary waters.	Annual catch.
OREGON AND WASHINGTON TERRITORY.	*Pounds.*
Chetco and Windchuck Rivers	120,000
Rogue River	475,000
Port Oxford Lake	3,000
Coquille River	400,000
Coos River	10,000
Umpqua River	950,000
Sinslaw River	15,000
Alsea River	45,000
Yaquina River	65,000
Nestachee River	5,000
Nehanan and Nehalem Rivers	10,000
Columbia River: Cowlitz River, Tilton River, Lewis River, Willamette River, Klikitat River, Deschutes River, John Day River, Umatilla River, Walla Walla and Touchit Rivers, Snake River, Palouse River, Tukannon River, Grande Ronde River, Clear Water River, Salmon River, Lemhi River, Payette River and Lake, Boise River, Owyhee River, Bruneau River, Goose Creek, Port Neuf River, Blackfoot River, Salt River, Yakima River, Okinakane, Spokane River and Hangman's Creek, Silver Lake, Crab Creek, Colville River and Pend d'Oreille Creek, Clarke's Fork of Columbia River	40,416,000
Shoalwater Bay and Gray's Harbor	500,000
Chehalis River: Black River and Newaukum Creek	375,000
Quilent River	80,000
Puget Sound: Des Chutes and Nisqually Rivers, Puyallup River, White, Black, Green, Cedar, and Dwamish Rivers, Snoqualmie and Stillaquamish Rivers, Skagit and Samish Rivers, Noosack River	1,534,200
TRIBUTARIES OF THE GREAT LAKES.	
LAKE SUPERIOR.	
Brulé and other rivers	85,000
Saint Louis River	215,000
Left Hand, Montreal, and other rivers	200,000
LAKE MICHIGAN.	
Green Bay: Sturgeon, Escanaba, Ford, and Cedar Rivers, Menominee River, Peshtigo and Oconto Rivers, Pensaukee and Suamico Rivers, and Duck Creek, Fox River, Lake Winnebago, Wolf River, Poygan and Rush Lakes, and Waushara County lakes, Waupaca County lakes, Green Lake County lakes, Mecan River and Marquette County lakes, Kewaunee County lakes, Twin Rivers, Manitowoc River, Sheboygan River. Sheboygan County lakes, Milwaukee River, Racine County lakes, Pike Creek, Calumet River and Lake, Saint Joseph River, Elkhart River, Turkey, Wolf, and other lakes, Pigeon River, Honey, Wall, Crooked, and other lakes, Galien Creek, Black and Paw-Paw Rivers, Kalamazoo River, Holland, Pigeon, and Rabbit Rivers, Grand River, Muskegon River, White River, Stoney Creek and Lake, Marquette River, Little and Grand Au Sable Rivers, and Hamlin and Lincoln Lakes, Manistee River, Traverse Bay, Bear, Boyne, Pine, and Jordan Rivers and Lakes, Elk, Round, Torch,	

Principal and tributary waters.	Annual catch.
RIBUTARIES OF THE GREAT LAKES—Continued.	*Pounds.*
LAKE MICHIGAN—continued.	
reen Bay—Continued.	
Clam, Grass, and intermediate lakes and rivers, Boardman River, Leelenaw, Benzie, and Grand Traverse County lakes	5, 192, 000
LAKE HURON.	
eboygan River	200, 000
evil and Thunder Bay Rivers and Long Lake	100, 000
u Sable River	160, 000
ginaw Bay: Pine and Rifle Rivers	95, 000
ginaw River: Cass River, Tittabawassee River, Flint and Shiawassee Rivers	390, 000
geon River	60, 000
LAKE ERIE.	
ake Saint Clair: Clinton River, Saint Clair River, Belle, Pine, and Black Rivers, Detroit River, Rouge River, Huron River, Raisin River, Maumee River, Saint Mary's and Saint Joseph's Rivers, and Tiffin's Creek, Portage River, Sandusky River, Vermillion and Huron Rivers, Rocky and Black Rivers, Cuyahoga River, Chagrin River, Grand River, Ashtabula Creek, Buffalo, Eighteen Mile, and Cattaraugus Creeks	4, 155, 000
LAKE ONTARIO.	
iagara River, Tonawanda Creek, Eighteen Mile, Johnson's, Oak Orchard, Sandy and Salmon Creeks, Genesee River, Oatka Creek, Conesus, Hemlock, Honeoye, and Silver Lakes, Irondequoit Creek, Sodus Bay and tributaries, Oswego River, Oneida River, Oneida Lake, Fish and Oneida Creeks, Chittenango River, and Cazenovia Lake, Seneca River, Cross Lake, Onondaga Lake, Otisco Lake and outlet, Skaneateles Lake, Owasco River and Lake, Clyde River, Canandaigua Lake, West River, Cayuga Lake, Salmon Creek and Dryden Lake, Seneca Lake, Crooked or Keuka Lake, Salmon River, Sandy and Bedford Creeks, Black River, Beaver River, Moose River, Chaumont Bay and River	4, 265, 000

Principal and tributary waters.	Annual catch.
MISCELLANEOUS.	*Pounds.*
Ohio.	
Artificial lakes:	
Paulding County Reservoir	150, 000
Mercer County Reservoir	625, 000
Shelby County Reservoir	250, 000
Lewistown Reservoir	150, 000
Licking Reservoir	350, 000
Minnesota and Dakota.	
Red River of the North; Two River, Tamarac, Middle, and Snake Rivers, Red Lake River and Lake, Wild Rice River, Sheyenne River, Buffalo, Red, Pelican and Ottertail Rivers, &c., Rabbit River, Traverse Lake	617, 000
Dakota.	
Devil's Lake	2, 000
Spirit Wood Lake	3, 000
Lake Hendricks	2, 000
Lake Poinsett	600
Lakes at Norden	3, 000
Lake Madison	5, 000
Herman Lake	2, 000
Other Dakota lakes	7, 000
Utah, Wyoming, and Idaho.	
Great Salt Lake, Bear River, Malad and Little Malad Rivers, Bear Lake, Weber River, Jordan River, Utah Lake	178, 000
Utah.	
Stockton Lake	40, 000
Sevier River	10, 000
San Pitch River	5, 000
Panquitch River	40, 000
Nevada and California.	
Pyramid Lake, Truckee River, Lake Tahoe	1, 070, 000
Walker Lake, Walker River	80, 000
Carson River	22, 000
Humboldt River, Reese River	12, 000
Quin River	2, 000
Pahranagat Lake	500
California.	
Owen's River, Gold, Eagle, Honey, and Horse Lakes, &c	110, 000
Oregon.	
Selvies River and Rattlesnake Creek	2, 000

RECAPITULATION.

States and river systems.	Annual catch.
	Pounds.
aine	4, 549, 500
ermont	1, 337, 500
assachusetts	3, 498, 000
hode Island	1, 011, 000
onnecticut	1, 121, 200
ew York	4, 688, 000
ew Jersey	10, 950, 000
elaware	2, 160, 000
aryland	11, 600, 000
irginia	8, 130, 000
orth Carolina	6, 349, 300
uth Carolina	3, 162, 500
eorgia	1, 930, 000
orida	1, 245, 000
abama	1, 668, 000
ississippi and Louisiana	1, 922, 000
ississippi River system	36, 824, 000
ouisiana and Texas	3, 594, 750

States and river systems.	Annual catch.
	Pounds.
California	15, 184, 000
Oregon and Washington Territory	45, 093, 200
Lake Superior	500, 000
Lake Michigan	5, 192, 000
Lake Huron	1, 005, 000
Lake Erie	4, 155, 000
Lake Ontario	4, 265, 000
Ohio	1, 525, 000
Minnesota and Dakota	617, 000
Dakota lakes	24, 600
Utah, Wyoming, and Idaho	178, 000
Utah	95, 000
Nevada and California	1, 186, 500
California	110, 000
Oregon	2, 000
Total	184, 783, 050

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[NOTE.—The references are to page-figures in brackets.]

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Alloways Creek	2
Alsea River	6
Altamaha River	3
Altoyac Creek	5
American River	6
Amite River	3
Ammonoosuc River	1
Anclote River	3
Anderson's Creek	4
Androscoggin River	1
Angelina River	5
Annemessex River	2
Appalachee Creek	3
Apple Creek	5
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Santa Fe River	3
Santa Margarita River	6
Santa Rosa River	6

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Santee River	3
Sapelo River	3
Saranac Lake	1
Saranac River	1
Sarasota Bay	3
Saratoga Lake	2
Sassafras River	2
Saugatuck River	1
Saugus River	1
Sauk Lakes	5
Sauk River	5
Savannah River	3
Schoodic Lake	1
Schorarie River	1
Schroon Lake	2
Schroon River	2
Schuyler's (Canaderaga) Lake	2
Schuylkill River	2
Schwartzwood Lake	2
Scioto River	4
Scuppernong River	3
Sebago Lake	1
Sebasticook River	1
Selvies River	7
Seneca Lake	7
Seneca River	7
Sequatchie River	4
Severn River	2
Sevier River	7
Shark River	2
Shasta River	6
Sheboygan River	6
Sheepscott River	1
Shelby County Reservoir	7
Shell Rock Creek	5
Shenandoah River	2
Shenango Creek	4
Shepaug River	1
Sherman Creek	2
Shetucket River	1
Sheyenne River	7
Shiawassee River	7
Shoal Creek	3, 4
Shoalwater Bay	6
Shooner River	4
Shrewsbury River	1
Silver Creek	3, 4
Silver Lake	5, 6, 7
Sims Creek	4
Sinnemahoning River	2
Sinslaw River	6
Sippican River	1
Sipsey River	3
Skagit River	6
Skaneateles Lake	7
Skillet Fork	4
Skunk River	5
Slate Creek	4
Slate River	2
Slippery Rock Creek	4
Smith River	6
Smith's Fork	6
Smith's River	3
Smoky Hill River	5
Snachwine Lake	5
Snake River	6, 7
Snoqualmie River	6
Sodus Bay	7
Soldier Creek	5
Soldier River	5
Soloman River	5
Songo River	1
South River	1, 2, 3
South Anna River	2
South Fork of Cheyenne River	5
South Fork of Shenandoah River	2
South Newport River	3
South Platte River,	5
South Toe River	4
Spirit Lake	5
Spirit Wood Lake	7
Split Lake	2
Spokane River	6
Spoon River	5
Spring Lake	5
Spring River	4
Spunk River	5
Stanislaus River	6
Staunton River	3
Steinhatchee River	3
Stillaquamish River	6
Stockton Lake	7
Stone Creek	4
Stone River	4
Stoney Creek	6
Stoney Lake	6
Stony Creek	6
Storm Lake	5
Stow Creek	2
Stranger Creek	5
Strawberry River	4
Strong River	3
Sturgeon River	6
Suamico River	6
Sucarnochee River	3
Sudbury River	1
Sug Creek	5
Sugar Creek	2, 3, 4
Sugar River	1
Sulphur Fork	4
Sunflower River	4
Susquehanna River	2
Suwannee River	3
Swamp Creek	3
Swan Creek	4
Swan Lake	5
Swan River	5
Swift River	1
Talladega Creek	3
Tallahala Creek	3
Tallahatchee River	4
Tallapoosa River	3
Tallasee Creek	3
Tallasseehatchee Creek	3
Tamarac River,	7
Tamicki Creek	6
Tampa Bay	3
Tangipohoa River	3
Tapashaw Creek	4
Tarkio River	5
Taunton River	1
Ten Mile Creek	4, 6

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Tennessee River	4
Tensas Bayou	4
Tensaw River	3
Tesantee Creek	3
Thames River	1
Thompson Lake	1,5
Thunder Bay River	7
Tibbee River	3
Tiffin's Creek	7
Tiger River	3
Tilton River	6
Timbalier Bay	5
Timber Lake	5
Tioga River	2
Tionesta Creek	4
Tioughnioga River	2
Tippecanoe River	4
Tittabarrassee River	7
Toddy Pond	1
Tombigbee River	3
Tonawanda Creek	7
Tonis River	2
Torch Lake	6
Touchit River	6
Towanda Creek	2
Town Creek	2
Trade River	5
Tradewater River	4
Transquaking River	1
Traverse Bay	6
Traverse Lake	7
Trempealeau River	5
Trent River	3
Trespalacios Creek	6
Trinity River	5,6
Trout River	2
Truckee River	7
Trumball Lake	5
Tuckahoe River	2
Tuckasegee River	4
Tug River	4
Tugaloo River	3
Tukannon River	6
Tulare Lake	6
Tule Lake	6
Tule River	6
Tunk River	1
Tunkhannock Creek	2
Tuolumne River	6
Turkey Creek	3,4
Turkey Lake	6
Turkey River	5
Tuscaloosa River	3
Tuscarawas River	4
Tuscumbia River	5
Twin Lakes	5
Twin Rivers	6
Two River	5,7
Two Lick Creek	4
Tygart's Creek	4
Tygert's Valley River	4
Tyronza River	5
Ty Ty Creek	3
Umatilla River	6
Umbagog River	1
Umpqua River	6
Unadilla River	2
Uncompahgre River	6
Union River	1
Upper Iowa River	5
Upper Little River	3
Utah Lake	7
Van Dusen's Fork	6
Venango River	4
Verdigris River	4
Vermillion Creek	5
Vermillion River	4,5,7
Village Creek	5
Volga River	5
Wabash River	4
Wacasassa River	3
Waccamaw Lake	3
Waccamaw River	3
Wacissa River	3
Wading River	2
Wakarusa River	5
Walden Creek	4
Walen Paupac Creek	2
Walhonding River	4
Walker Lake	7
Walker River	7
Walker's Creek	4
Walkill River	1
Wall Lake	5,6
Walla Walla River	6
Wallum Lake	1
Walnut Creek	4,5
Wapetomica River	4
Wapsipinicon River	5
War Eagle Creek	4
Ware River	1,2
Wareham Pond	1
Warren River	1
Warrior Creek	3
Washita River	4
Watauga River	4
Wateree River	3
Watonwan River	5
Wea Creek	5
Weber River	7
Weld Pond	1
Wenham Pond	1
West Creek	2
West River	1,2,7
West Canada Creek	1
Westfield River	1
West Fork of White River	4
Westport River	1
Weweautitt River	1
White River	4,5,6
White Fish Lake	5
White Lick Creek	4
White Mountain River	6
White Oak Creek	3,4
White Oak Pond	2
White Oak River	3
White Rock Creek	5
White Water River	4
Wicomico River	2
Wild Cat Creek	4
Wild Rice River	7
Willamette River	6

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Willis River	2
Willow Creek	3
Willow River	5
Wills Creek	2, 3, 4
Wind River	5
Windchuck River	6
Winetuxet River	1
Winnibigoshish Lake	5
Winnipiseogee Lake	1
Winnipiseogee River	1
Winooski, or Onion River	1
Winyah Bay	3
Wisconsin River	5
Wisserunset River	1
Withcacoochee River	3
Withlocoochee River	3
Wolf Creek	3, 5
Wolf Lake	6
Wolf River	3, 5, 6
Wye River	2
Yakima River	6
Yalabusha River	4
Yaquina River	6
Yazoo Pass	4
Yazoo River	4
Yellow Creek	4
Yellow River	3, 5
Yellow Leaf Creek	3
Yellow Medicine River	5
Yellowstone River	5
Yequa River	6
Ynez River	6
Yockanockany River	3
Yocona River	4
York River	1, 2
Youghiogheny River	4
Young Woman Creek	2
Yuba River	6
Zumbro River	5

VI.—STATISTICS OF THE UNITED STATES IMPORTS AND EXPORTS OF FISH, FISH-OIL, WHALEBONE, THE TONNAGE OF FISHING VESSELS, ETC., FOR THE YEAR ENDING JUNE 30, 1883.

By CHAS. W. SMILEY.

A.—IMPORTS.

1. Dutiable.—Quantities and values, by countries.
2. Free.—Quantities and values, by countries.
3. Products of the fisheries.—Quantities and values, by countries.
4. Summary for eleven years.—I. Free. II. Dutiable. (Quantities.)
5. Summary for eleven years.—I. Free. II. Dutiable. (Values.)

B.—EXPORTS.

6. Domestic products.—Quantities and values, by countries.
7. Foreign products.—Quantities and values, by countries.
8. Summary for eleven years.—Quantities. (Domestic products.)
9. Summary for eleven years.—Values. (Domestic products.)
10. Summary for eleven years.—Quantities. (Foreign products.)
11. Summary for eleven years.—Values. (Foreign products.)

C.—TONNAGE.

12. Summary, 1789–1883.—Whale, cod, and mackerel.
13. Cod and mackerel, 1883, by customs districts.
14. Whale, 1883, by customs districts.

The following tables have been prepared from the annual report of the Bureau of Statistics of the Treasury Department, and are based on the custom-house returns.

The clerical work has been performed under my direction by Messrs. M. P. Snell, E. Y. Davidson, and H. P. Jerrell.

TABLE I.—*Quantities and values of the dutiable fishery-products imported into the United States during the year ending June 30, 1883.*

Countries from which imported.	Fish.							Minor and secondary products.				Grand total.
	Herring (pickled).		Mackerel (pickled).		Sardines and anchovies preserved in oil.	All other kinds.	Total.	Fish-oil and whale-oil.		Sponges.	Total.	
	Barrels.	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria					14, 465	6	14, 471					14, 471
China						75, 018	75, 018	8, 000	1, 546		1, 546	76, 564
Denmark	12	65			140	3, 360	3, 565	3, 598	2, 335		2, 335	5, 900
France	312	2, 972			683, 467	5, 233	691, 672	25	45		45	691, 717
Germany	9, 958	96, 844			4, 487	14, 502	115, 833	12, 163	10, 395		10, 395	126, 228
England	37	356			186, 826	5, 749	192, 931	8, 579	8, 044		8, 044	200, 975
Scotland	42	615				1, 102	1, 717					1, 717
Nova Scotia, New Brunswick, and Prince Edward Island						18	18	156	76		76	94
Quebec, Ontario, Manitoba, and the Northwest Territory	2, 376	14, 088	19	148		47, 352	61, 588	1, 000	569		569	62, 157
British Columbia						104, 752	104, 752	47, 060	16, 805		16, 805	121, 557
Italy					801	1, 447	2, 248	100	72		72	2, 320
Japan						3, 224	3, 224	49, 128	12, 903		12, 903	16, 127
Netherlands	32, 605	361, 303			6, 040	5, 465	372, 808					372, 808
Sweden and Norway	3, 485	22, 721			1, 892	29, 884	54, 497	24, 158	22, 500		22, 500	76, 997
Other countries	6	12			13, 550	24, 951	38, 513	2, 055	1, 263	295, 250	296, 513	335, 026
Total	48, 833	498, 976	19	148	911, 668	322, 063	1, 732, 855	156, 022	76, 553	295, 250	371, 803	2, 104, 658

TABLE II.—*Quantities and values of the fishery-products imported into the United States free of duty during the year ending June 30, 1883.*

Country from which imported.	Fresh fish of all kinds.		Prepared fish.						Secondary products.										Grand total.
			Herring (pickled).		Mackerel (pickled).		All other kinds.	Total.	Fish-oil and whale-oil.		Fish-sounds.		Isinglass or fish-glue.		Whalebone.		Coral.	Total.	
	Pounds.	*Dolls.*	*Bbls.*	*Dolls.*	*Bbls.*	*Dolls.*	*Dollars.*	*Dollars.*	*Galls.*	*Dolls.*	*Lbs.*	*Dolls.*	*Lbs.*	*Dolls.*	*Lbs.*	*Dolls.*	*Dolls.*	*Dollars.*	*Dollars.*
Nova Scotia, New Brunswick, and Prince Edward Island	6, 854, 004	251, 409	65, 011	236, 348	49, 730	406, 410	1, 509, 005	2, 151, 763	198, 435	98, 412	......	......	......	......	......	......	......	98, 412	2, 501, 584
Quebec, Ontario, Manitoba, and the Northwest Territory	8, 599, 751	314, 845	22, 621	119, 299	2, 363	20, 917	64, 465	204, 681	39, 106	38, 252	......	......	......	......	......	......	......	38, 252	557, 778
British Columbia	3, 491	208	......	......	......	......	4	4	......	......	......	......	......	......	......	......	......	......	212
Newfoundland and Labrador	909, 000	5, 965	13, 712	62, 676	......	......	199, 300	261, 976	42, 599	36, 458	......	......	......	......	......	......	......	36, 458	304, 399
British West Indies	......	......	......	......	......	......	537	537	......	......	......	......	......	......	......	......	......	......	537
Mexico	2, 320	99	......	......	......	......	418	418	......	......	......	......	......	......	......	......	......	......	517
United States of Colombia	......	......	......	......	......	......	10	10	46, 461	30, 486	......	......	......	......	......	......	......	30, 486	30, 496
Other countries	......	......	......	......	......	......	907	907	7	3	28, 352	16, 748	258, 504	162, 420	1, 721	1, 773	443	181,387	182, 294
Total	16, 368, 476	572, 526	101, 344	418, 323	52, 093	427, 327	1, 774, 646	2, 620, 296	326, 608	203, 611	28, 352	16, 748	258, 504	162, 420	1, 721	1, 773	443	384, 995	3, 577, 817

TABLE III.—*Quantities and values of the products of the fisheries, taken by American vessels and fishermen, brought into the United States during the year ending June 30, 1883.*

Products.	Quantities.	Values.
Of the whale fisheries:		*Dollars.*
Sperm-oil .... gallons..	810, 959	847, 996
Other whale-oil .... do....	946, 938	516, 182
Whalebone or baleen .... pounds..	340, 571	478, 419
Ambergris .... do....	183	23, 450
Other whale products	....	810
Other products of the American whale fisheries	....	17, 550
Total	....	1, 884, 407
Of other fisheries: *		
Codfish, cured .... cwts....	278, 521	1, 249, 871
Mackerel, cured .... do....	192, 619	795, 781
Herring, cured .... do....	86, 207	134, 199
Other fish, cured .... do....	57, 680	162, 715
Oysters .... bushels..	14, 476	21, 202
Other shell-fish	....	240, 372
Fresh fish, not shell-fish .... pounds..	34, 237, 931	1, 159, 778
Oils, other than whale .... gallons..	1, 249, 091	508, 216
Shell and bone, other than whalebone	....	1, 884
Teeth .... pounds..	19, 646	14, 822
Skins .... number..	7, 540	5, 125
Manure .... tons..	18, 422	450, 061
All other products of the American fisheries	....	49, 202
Total	....	4, 793, 228
Total value of products of the American fisheries	....	6, 677, 635

* This information, in regard to fishery-products othen than whale, is incomplete, owing to the fact that there is no law requiring all products of the fisheries to be reported to the customs officers when landed within a customs district. It is compiled chiefly from information obtained through the personal efforts and inquiries of the customs officers of the several ports from which it is practicable to obtain returns.

TABLE IV.—*Quantities of fish and oil imported into the United States during the eleven years ending June 30, 1883.*

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds......pounds..	8, 636, 279	9, 587, 595	15, 308, 769	10, 723, 216	7, 735, 981	9, 681, 828	8, 432, 835	10, 761, 307	12, 975, 761	15, 893, 849	16, 368, 476	126, 105, 896
Herring, pickled........barrels..	....	51, 423	70, 763	87, 554	63, 280	58, 082	55, 732	46, 723	64, 811	76, 136	101, 344	675, 848
Mackerel, pickled ......barrels..	....	89, 503	77, 479	76, 531	43, 066	102, 148	101, 420	112, 468	120, 288	58, 279	52, 093	833, 275
Oils:												
Whale or fish, not of American fisheries ....gallons..	....	165, 448	277, 739	103, 184	138, 708	311, 091	182, 625	407. 416	568, 660	337, 076	326, 608	2, 818, 555
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring ....barrels..	68, 692	31, 128	21, 581	17, 268	14, 873	15, 542	18, 950	26, 168	30, 987	36, 061	48, 833	330, 083
Mackerel ....barrels..	90, 889	190	59	7	14	6	2	....	9	164	19	91, 359
Oils:												
Whale and fish, not of American fisheries ....gallons..	223, 612	226, 528	115, 084	102, 883	51, 882	85, 509	61, 509	92, 819	146, 410	209, 051	156, 022	1, 471, 309

TABLE V.—*Values of the fish and oil imported into the United States during the eleven years ending June 30, 1883.*

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds	$278, 921	$294, 837	$351, 889	$271, 597	$236, 098	$339, 561	$283, 827	$320, 403	$376, 508	$488, 925	$572, 526	$3, 815, 092
Herring, pickled	(*a*)	181, 521	288, 590	306, 555	210, 786	230, 533	192, 069	154, 003	236, 402	265, 797	418, 323	2, 484, 580
Mackerel, pickled	(*a*)	800, 920	584, 283	695, 412	372, 260	907, 246	649, 721	493, 059	614, 729	396, 149	427, 327	5, 941, 106
All other not elsewhere specified	(*b*)	553, 949	928, 344	501, 154	581, 592	637, 437	763, 915	912, 336	1, 088, 336	1, 366, 963	1, 774, 646	9, 108, 672
Oils:												
Whale or fish, not of American fisheries	(*b*)	91, 944	161, 289	62, 438	84, 088	176, 384	80, 701	170, 525	293, 600	158, 878	203, 611	1, 483, 456
Total	278, 921	1, 923, 171	2, 314, 395	1, 837, 156	1, 484, 824	2, 291, 161	1, 970, 233	2, 050, 326	2, 609, 576	2, 676, 712	3, 396, 433	22, 832, 908
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring, pickled	359, 262	253, 044	226, 494	186, 535	189, 615	180, 840	189, 204	288, 407	290, 073	375, 617	498, 976	3, 038, 067
Mackerel, pickled	610, 457	1, 550	553	48	148	67	14	....	97	1, 179	148	614, 261
Sardines and anchovies preserved in oil or otherwise	1, 172, 704	991, 030	526, 179	595, 901	773, 331	677, 910	912, 391	1, 102, 410	987, 394	860, 760	911, 668	9, 511, 678
All other not elsewhere specified	663, 913	131, 676	102, 283	96, 046	91, 654	149, 852	118, 050	132, 684	142, 158	294, 606	322, 063	2, 244, 985
Oils:												
Whale and fish, not of American fisheries	106, 294	121, 927	70, 404	63, 286	44, 015	56, 616	45, 903	55, 133	82, 584	103, 020	76, 553	825, 735
Total	2, 912, 630	1, 499, 227	925, 913	941, 816	1, 098, 763	1, 065, 285	1, 265, 562	1, 578, 634	1, 502, 306	1, 635, 182	1, 809, 408	16, 234, 726

a. Included in dutiable "Fish, other."

b. Included in dutiable, same class.

TABLE VI.—*Quantities and values of the domestic fishery-products exported from the United States during the year ending June 30, 1883.*

Countries to which exported.	Fresh fish of all kinds.	Prepared fish. Dried or smoked.		Pickled.		All other kinds.	Total.	Oysters.	Minor and secondary products. Sperm-oil.		Other whale and fish oil.		Spermaceti.		Whalebone.		Other products.	Total.	Grand total.
	Dolls.	Cwts.	Dolls.	Bbls.	Dolls.	Dolls.	Dolls.	Dolls.	Galls.	Dolls.	Galls.	Dolls.	Lbs.	Dolls.	Lbs.	Dolls.	Dolls.	Dolls.	Dolls.
1. Argentine Republic				2	17	11, 929	11, 946	5, 463	100	110								110	17, 519
2. Austria																			
3. Belgium						252	252		505	615	2, 400	1, 200			5, 281	11, 488		13, 303	13, 555
4. Brazil		80	535	10	65	4, 357	4, 957	1, 707	940	1, 140								1, 140	7, 804
5. Central American states		1, 323	9, 798	204	1, 948	8, 829	20, 575	1, 059	92	123	135	60						183	21, 817
6. Chili				1	11	5, 597	5, 608	4, 203	110	135								135	9, 946
7. China						5, 748	5, 748		10	8								8	5, 756
8. Denmark						2, 906	2, 906	636											3, 542
9. Danish West Indies		639	3, 110	596	2, 771	1, 225	7, 106	209	10	11	50	46						57	7, 372
10. France						16, 443	16, 443	1, 188			58, 929	34, 110	5, 488	991	115, 597	245, 421		280, 522	298, 153
11. French West Indies		4, 537	23, 874	502	3, 930	8, 523	36, 327	3			1, 440	864						864	37, 194
12. French Guiana		8, 896	41, 837	398	3, 283	1, 379	46, 499												46, 499
13. Miquelon, Langley, and St. Pierre Islands																			
14. French Possessions, all other		47	216	252	2, 506	13, 966	16, 688	12											16, 700
15. Germany				43	1, 105	84, 199	85, 304	13, 113	4, 687	5, 831	160	98	142, 639	24, 200	175, 794	289, 646		319, 775	418, 192
16. England		78	466	250	2, 858	1, 867, 453	1, 870, 777	365, 626	157, 970	166, 073	35, 371	13, 043	212, 844	35, 502	29, 725	52, 400		267, 018	2,503,421
17. Scotland		98	500			1, 669	2, 169	5, 871	99, 718	106, 605	32, 792	19, 753	34, 051	5, 608				131, 966	140, 006
18. Ireland						53, 076	53, 076												53, 076
19. Gibraltar						6	6	12											18
20. Nova Scotia, New Brunswick, and Prince Edward Island	1, 012	3, 687	15, 773	4, 030	27, 069	1, 111	43, 953	10, 798	45	61								61	55, 824
21. Quebec, Ontario, Manitoba, and the Northwest Territory	42, 197	6, 260	44, 529	265	2, 087	75, 268	121, 884	152, 706	4, 875	2, 830	34, 040	15, 225			181	300		18, 355	335, 142
22. British Columbia	4	921	3, 256			14, 919	18, 175	6, 751	20	26								26	24, 956
23. Newfoundland and Labrador		343	2, 000				2, 000	125											2, 125
24. British West Indies	670	15, 486	88, 381	6, 928	46, 830	28, 226	163, 437	3, 007	63	68	5, 383	2, 956						3, 024	170, 138
25. British Guiana		641	2, 751	682	6, 667	2, 047	11, 465	851											12, 316
26. British Honduras		1, 061	6, 344	229	2, 168	3, 211	11, 723	152			10	4						4	11, 879
27. British East Indies																			
28. Hong Kong						207, 790	207, 790	18			4, 629	2, 177						2, 177	209, 985
29. British Possessions in Africa and adjacent islands		319	1, 295	85	660	10, 833	12, 788	396											13, 184

TABLE VI.—*Quantities and values of the domestic fishery-products exported from the United States during the year ending June 30, 1883.*—Continued.

Countries to which exported.	Fresh fish of all kinds.	Prepared fish.						Oysters.	Minor and secondary products.										Grand total.
		Dried or smoked.		Pickled.		All other kinds.	Total.		Sperm-oil.		Other whale and fish oil.		Spermaceti.		Whalebone.		Other products.	Total.	
	Dolls.	*Cwts.*	*Dolls.*	*Bbls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Galls.*	*Dolls.*	*Galls.*	*Dolls.*	*Lbs.*	*Dolls.*	*Lbs.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
30. British Possessions in Australasia		1,142	9,450	1,836	21,148	514,240	544,838	25,850			21,394	9,434						9,434	580,122
31. British Possessions, all other																			
32. Greece																			
33. Hawaiian Islands		67	572	3,617	41,226	82,281	124,079	4,624	96	106	717	322						428	129,131
34. Hayti		45,160	269,772	22,587	158,954	23,934	452,660	388	95	104	10	6						110	453,158
35. Italy						500	500						1,847	350				350	850
36. Japan						5,522	5,522	62							203	176		176	5,760
37. Liberia		195	977	847	5,063	6,025	12,065												12,065
38. Mexico	21	201	1,534	280	2,421	24,129	28,084	7,223	360	478	2,519	1,440						1,918	37,246
39. Netherlands		7	40	20	140	1,056	1,236	221	20	25	23,428	13,050						13,075	14,532
40. Dutch West Indies	80	864	4,527	141	1,111	3,455	9,093	569	97	85	48	20						105	9,847
41. Dutch Guiana		20,432	87,043	1,158	8,601	465	96,109												96,109
42. Dutch East Indies						175	175		300	278								278	453
43. Peru						6,166	6,166	1,339	100	100								100	7,605
44. Portugal		3	15	4	45		60												60
45. Azores, Madeira, and Cape Verde Islands		365	2,283	2	10		2,293												2,293
46. Portuguese Possessions in Africa and adjacent islands																			
47. Russia on the Baltic and White Seas																			
48. Russia on the Black Sea																			
49. Russia, Asiatic						38	38												38
50. San Domingo		4,922	26,234	1,512	12,153	11,225	49,612	122	5	9	381	227						236	49,970
51. Spain				3	21	677	698												698
52. Cuba	28,891	33,575	190,248	201	1,497	28,141	219,886	5,316	193	212	2,724	1,202						1,414	255,507
53. Porto Rico		884	5,387	99	761	6,864	13,012	211			50	38						38	13,261
54. Spanish Possessions in Africa and adjacent islands		9	48			880	928	12											940
55. Spanish Possessions, all other						19	19												19
56. Sweden and Norway								48											48
57. Turkey in Europe																			
58. Turkey in Asia				25	385	200	585												585

59. Turkey in Africa																			
60. United States of Colombia		5, 071	33, 691	1, 689	14, 339	37, 781	85, 811	3, 496	4, 610	5, 384	373	215			54	119		5, 718	95, 025
61. Uruguay						1, 781	1, 781	1, 480											3, 261
62. Venezuela		1, 132	6, 344	35	275	6, 738	13, 357	2, 924											16, 281
63. All other countries and ports in South America not elsewhere specified						2, 626	2, 626	1, 845											4, 471
64. All other countries and ports in Africa not elsewhere specified						181	181												181
65. All other countries and ports not elsewhere specified				18	260	6, 351	6, 611										32, 331	32, 331	38, 942
Total	72, 875	158, 445	882, 830	48, 551	372, 385	3, 202, 412	4, 457, 627	629, 636	275, 021	290, 417	226, 983	115, 490	396, 869	66, 651	326, 835	599, 550	*32, 331	1, 104, 439	6, 264, 577

* This amount includes 2,771 barrels of clams, valued at $21,308, and sponges to the amount of $7,518; also 51,109 pounds of "fish and whale foots," valued at $3,350, and 155 dollars' worth of fish-eggs. The exports of sea-weed and shells, which have a combined value of about $30,000, are not considered within the scope of the present series of tables.

TABLE VII.—*Quantities and values of the foreign fishery-products exported from the United States during the year ending June 30, 1883.*

Countries to which exported.	Free of duty.						Dutiable.										Grand total.
	Fish.					Total.	Fish.					Minor and secondary products.				Total.	
	Herring (pickled).		Mackerel (pickled).		All other kinds.		Mackerel (pickled).		Sardines and anchovies preserved in oil.	All other kinds.	Total.	Whale and fish oil.		Sponges.	Total.		
	Bbls.	*Dolls.*	*Bbls.*	*Dolls.*	*Dollars.*	*Dollars.*	*Bbls.*	*Dolls.*	*Dollars.*	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Central American states									2,612	13	2,625	40	29		29	2,654	2,654
Denmark					1,495	1,495											1,495
France and French Possessions					5,136	5,136			442	443	885					885	6,021
Germany					3,763	3,763	14	286		2,100	2,388					2,388	6,151
England					45,080	45,080				7,862	7,862					7,862	52,942
Scotland					37	37											37
Nova Scotia, New Brunswick, and Prince Edward Island	79	237	53	380	3,454	4,071											4,071
Quebec, Ontario, Manitoba, and the Northwest Territory					2,307	2,307			13,789	94,393	108,182	340	227		227	108,409	110,716
British Columbia									139	2,013	2,153					2,152	2,152
Newfoundland and Labrador					1,000	1,000				27	27					27	1,027
British West Indies			55	490	9,720	10,210	75	431	93	5,117	5,641	3	2		2	5,643	15,853
Other British Possessions	50	200			25,182	25,382			611	1,279	1,890					1,890	27,272
Hawaiian Islands									1,097	5,468	6,565					6,565	6,565
Hayti	50	300			375	675			37	6,539	6,576					6,576	7,251
Mexico									12,159	2,943	15,102					15,102	15,102
Netherlands					60	60				985	985	1,425	1,849		1,849	2,834	2,894
Peru										1,449	1,449					1,449	1,449
San Domingo									1,034		1,034					1,034	1,034
Cuba					366	366				34,716	34,716	43	29		29	34,745	35,111
Porto Rico										9,520	9,520					9,520	9,520
South American countries not elsewhere specified					2,852	2,852			85		85					85	2,937
Sweden and Norway					2,433	2,433											2,433
United States of Colombia					337	337			3,015	3,995	7,010					7,010	7,347
All other islands and ports not elsewhere specified										12	12			34,167	34,167	34,179	34,179
Total	179	737	108	870	103,597	105,204	89	719	35,113	178,874	214,706	1,851	2,136	34,167	36,303	251,009	356,213

TABLE VIII.—*Quantities of fish, oils, spermaceti, and whalebone exported from the United States during the eleven years ending June 30, 1883.*

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
Fish:												
Dried or smoked ....cwts..	118, 076	129, 982	129, 752	175, 528	159, 648	188, 831	179, 130	197, 450	212, 691	159, 512	158, 445	1, 809, 045
Pickled ....barrels..	16, 747	29, 000	51, 025	54, 291	76, 227	57, 554	47, 764	54, 345	52, 092	38, 224	48, 551	525, 820
Oils:												
Whale and other fish ....gallons..	288, 263	573, 775	895, 907	1, 067, 515	1, 026, 038	904, 988	2, 236, 265	1, 022, 889	597, 812	1, 083, 925	226, 983	9, 924, 360
Sperm	756, 306	529, 903	491, 130	892, 762	634, 991	723, 398	812, 928	482, 153	314, 568	540, 064	275, 021	6, 483, 224
Spermaceti ....pounds..	197, 671	304, 865	238, 641	141, 157	153, 552	228, 276	147, 503	197, 847	214, 205	265, 593	396, 869	2, 486, 179
Whalebone ....pounds..	324, 653	114, 530	251, 572	154, 500	71, 708	154, 016	78, 322	131, 332	227, 117	220, 787	326, 835	2, 055, 372

TABLE IX.—*Values of fish, oils, spermaceti, and whalebone exported from the United States during the eleven years ending June 30, 1883.*

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
Fish:												
Fresh	$64, 577	$56, 974	$69, 448	$80, 879	$114, 338	$84, 278	$80, 437	$124, 962	$97, 539	$89, 148	$72, 875	$935, 455
Dried and smoked	569, 151	612, 589	710, 121	900, 306	791, 785	766, 154	748, 747	739, 231	840, 199	635, 155	882, 830	8, 196, 268
Pickled	109, 201	226, 041	359, 669	417, 281	486, 738	416, 162	290, 862	284, 293	264, 723	244, 454	372, 385	3, 471, 809
Other cured	677, 171	1, 128, 208	1, 855, 550	2, 102, 522	2, 486, 225	3, 198, 896	2, 939, 587	2, 326, 444	2, 803, 330	3, 218, 581	3, 202, 412	25, 938, 926
Oils:												
Whale and other fish	154, 243	280, 750	413, 411	436, 072	442, 165	411, 808	756, 248	349, 109	229, 726	420, 730	115, 490	4, 009, 752
Sperm	1, 095, 831	827, 991	847, 014	1, 366, 246	879, 865	801, 218	719, 831	487, 004	303, 113	551, 212	290, 417	8, 169, 742
Spermaceti	55, 815	78, 346	61, 725	35, 915	41, 027	58, 302	35, 489	45, 018	40, 945	48, 721	66, 651	567, 954
Whalebone	329, 214	115, 098	291, 165	215, 327	160, 666	264, 980	199, 753	255, 847	326, 400	325, 333	599, 550	3, 083, 333
Total	3, 055, 203	3, 325, 997	4, 608, 103	5, 554, 548	5, 402, 809	6, 001, 798	5, 770, 954	4, 611, 908	4, 905, 975	5, 533, 334	5, 602, 610	54, 373, 239

TABLE X.—*Quantities of foreign fish and oils exported from the United States during the eleven years ending June 30, 1883.*

Description.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds .... pounds..			66, 728									66, 728
Herring, pickled .... barrels..	(a)	233	2, 318	2, 885	1, 903	21			624	101	179	8, 264
Mackerel, pickled .... barrels..	(a)	35	1, 300	885		356	171	272	842	60	108	4, 029
Oils:												
Whale or fish, not of American fisheries, gallons	(a)				43, 103	379, 570			880	10, 794		434, 347
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring .... barrels..	19, 928	4, 271	43		2							24, 244
Mackerel .... barrels..	36, 146	5, 334									89	41, 569
Oils:												
Whale or fish, not of American fisheries, gallons	35, 016	73, 429	29, 246	52, 730	1, 705	8, 800	5, 245	602	7, 939	11, 580	1, 851	228, 149

a. Included in dutiable, same class.

TABLE XI.—*Values of foreign fish and oils exported from the United States during the eleven years ending June 30, 1883.*

Description.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds	....	....	$3, 895	....	....	....	....	....	....	....	....	$3, 895
Herring, pickled	(a)	$1, 157	11, 576	$13, 305	$9, 088	$71	....	....	$1, 770	$381	$737	38, 085
Mackerel, pickled	(a)	358	10, 254	4, 515	....	2, 279	$684	$1, 260	3, 889	360	870	29, 469
All other not elsewhere specified	(a)	29, 411	133, 620	39, 618	32, 120	76, 144	206, 440	188, 265	59, 501	53, 644	103, 597	922, 360
Oils:												
Whale or fish, not of American fisheries	(a)	....	....	....	26, 669	217, 562	....	....	475	4, 715	....	249, 421
Total	....	30, 926	159, 345	57, 438	67, 877	296, 056	207, 124	189, 525	65, 635	59, 100	105, 204	1, 238, 230
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring, pickled	$81, 775	16, 650	146	....	22	....	....	....	....	....	....	98, 593
Mackerel, pickled	178, 328	29, 429	....	....	....	....	....	....	....	....	719	208, 476
Sardines and anchovies preserved in oil or otherwise	45, 452	59, 796	23, 296	19, 667	24, 780	30, 455	29, 149	36, 000	45, 839	47, 833	35, 113	397, 380
All other not elsewhere specified	213, 534	35, 803	23, 433	55, 905	135, 854	116, 266	54, 954	13, 632	69, 063	212, 620	178, 874	1, 109, 938
Oils:												
Whale or fish, not of American fisheries	25, 601	34, 196	11, 236	29, 482	794	8, 058	2, 363	331	3, 334	8, 848	2, 130	117, 379
Total	544, 690	175, 874	58, 111	96, 054	161, 450	154, 779	86, 466	49, 963	118, 236	269, 301	216, 842	1, 931, 766

a. Included in dutiable, same class.

TABLE XII.—*Tonnage of the United States vessels employed in the cod, mackerel, and whale fisheries from 1789 to 1883.*

Period.	Whale fisheries.			Cod fisheries.			Mackerel fisheries.	Total.
	Registered vessels.	Enrolled vessels.	Total.	Enrolled vessels.	Licensed vessels (under 20 tons).	Total.		
Year ending December 31—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1789	....	....	....	9,062	....	9,062	....	9,062
1790	....	....	....	28,348	....	28,348	....	28,348
1791	....	....	....	32,542	....	32,542	....	32,542
1792	....	....	....	32,062	....	32,062	....	32,062
1793	....	....	....	28,974	1,985	30,959	....	30,959
1794	....	4,129	4,129	17,498	5,550	23,048	....	27,177
1795	....	3,163	3,163	24,887	6,046	30,933	....	34,096
1796	....	2,364	2,364	28,509	6,453	34,962	....	37,326
1797	....	1,104	1,104	33,406	7,222	40,628	....	41,732
1798	....	763	763	35,477	7,269	42,746	....	43,509
1799	5,055	592	5,647	23,933	6,046	29,979	....	35,626
1800	2,814	652	3,466	22,307	7,120	29,427	....	32,893
1801	2,349	736	3,085	31,280	8,102	39,382	....	42,467
1802	2,621	580	3,201	32,988	8,534	41,522	....	44,723
1803	11,247	1,143	12,390	43,416	8,396	51,812	....	64,202
1804	12,016	323	12,339	43,088	8,926	52,014	....	64,353
1805	5,117	898	6,015	48,479	8,986	57,465	....	63,480
1806	9,778	729	10,507	50,353	8,830	59,183	....	69,690
1807	8,144	907	9,051	60,690	9,616	70,306	....	79,357
1808	3,802	724	4,526	43,598	8,400	51,998	....	56,524
1809	3,204	573	3,777	26,110	8,377	34,487	....	38,264
1810	3,250	339	3,589	26,251	8,577	34,828	....	38,417
1811	5,245	54	5,299	34,361	8,873	43,234	....	48,533
1812	1,988	942	2,930	21,822	8,637	30,459	....	33,389
1813	2,153	789	2,942	11,255	8,622	19,877	....	22,819
1814	....	562	562	8,863	8,992	17,855	....	18,417
1815	....	1,230	1,230	26,510	10,427	36,937	....	38,167
1816	....	1,168	1,168	37,879	10,247	48,126	....	49,294
1817	4,874	350	5,224	53,990	10,817	64,807	....	70,031
1818	16,135	615	16,750	58,552	10,555	69,107	....	85,857
1819	31,700	686	32,386	65,045	11,033	76,078	....	108,464
1820	35,391	1,054	36,445	60,843	11,197	72,040	....	108,485
1821	26,071	1,924	27,995	51,352	10,941	62,293	....	90,288
1822	45,449	3,134	48,583	58,405	10,821	69,226	....	117,809
1823	39,918	585	40,503	67,041	11,214	78,255	....	118,758
1824	33,166	180	33,346	68,239	9,208	77,447	....	110,793
1825	35,379	....	35,379	70,626	10,836	81,462	....	116,841
1826	41,757	227	41,984	63,535	10,121	73,656	....	115,640
1827	45,653	339	45,992	73,709	10,230	83,939	....	129,931
1828	54,621	180	54,801	74,765	10,922	85,687	....	140,488
1829	57,284	....	57,284	97,889	3,908	101,797	....	159,081
1830	38,912	793	39,705	58,041	3,515	61,556	35,973	137,234
1831	82,316	481	82,797	57,239	3,739	60,978	46,211	189,986
1832	72,869	377	73,246	51,725	3,303	55,928	47,428	175,702
1833	101,158	478	101,636	58,569	4,152	62,721	48,726	213,083
1834	108,060	364	108,424	52,473	3,931	56,404	61,082	225,910
Year ending September 30—								
1835*	97,649	....	97,649	72,374	4,964	77,338	64,443	239,430
1836	144,681	1,573	146,254	58,414	4,893	63,307	46,424	255,985
1837	127,242	1,895	129,137	75,055	5,497	80,552	46,811	256,500
1838	119,630	5,230	124,860	63,974	6,090	70,064	56,649	251,573
1839	131,845	440	132,285	65,167	7,091	72,258	35,984	240,527
1840	136,927	....	136,927	67,927	8,109	76,036	28,269	241,232
1841	157,405	....	157,405	60,556	5,996	66,552	11,321	235,278
1842	151,613	377	151,990	49,942	4,863	54,805	16,097	222,892
Year ending June 30—								
1843*	152,375	142	152,517	54,901	6,323	61,224	11,776	225,517
1844	168,294	320	168,614	78,179	7,046	85,225	16,171	270,010
1845	190,696	207	190,903	69,826	7,165	76,991	21,414	289,308
1846	186,980	440	187,420	72,516	6,802	79,318	36,463	303,201
1847	193,859	....	193,859	70,178	7,503	77,681	31,451	302,991
1848	192,180	433	192,613	82,652	7,195	89,847	43,558	326,018
1849	180,186	....	180,186	73,882	7,874	81,756	42,942	304,884
1850	146,017	....	146,017	85,646	8,160	93,806	58,112	297,935
1851	181,644	....	181,644	87,476	8,141	95,617	50,539	327,800
1852	193,798	....	193,798	102,659	7,914	110,573	72,546	376,917
1853	193,203	....	193,203	99,990	9,238	109,228	59,850	362,281
1854	181,901	....	181,901	102,194	9,734	111,928	35,041	328,870
1855	186,778	70	186,848	102,928	8,987	111,915	21,625	320,388
1856	189,213	248	189,461	95,816	6,636	102,452	29,887	321,800

* Nine months.

TABLE XII.—*Tonnage of the United States vessels employed in the cod, mackerel, and whale fisheries from* 1789 *to* 1883.—Continued.

Period.	Whale fisheries.			Cod fisheries.			Mackerel fisheries.	Total.
	Registered vessels.	Enrolled vessels.	Total.	Enrolled vessels.	Licensed vessels (under 20 tons).	Total.		
Year ending June 30—	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1857	195,772	70	195,842	104,573	7,295	111,868	28,328	336,038
1858	198,594	....	198,594	110,896	8,356	119,252	29,594	347,440
1859	185,728	....	185,728	120,577	9,060	129,637	27,070	342,435
1860	166,841	....	166,841	127,508	9,145	136,653	26,111	329,605
1861	145,734	....	145,734	127,311	10,535	137,846	54,795	338,375
1862	117,714	....	117,714	122,863	10,738	133,601	80,596	331,911
1863	99,228	....	99,228	106,560	10,730	117,290	51,019	267,537
1864	95,145	....	95,145	92,745	10,997	103,742	55,499	254,386
1865	84,233	6,283	90,516	59,227	5,958	65,185	41,209	196,910
1866	105,170	....	105,170	42,797	8,845	51,642	46,589	203,401
1867	52,384	....	52,384	36,709	7,858	44,567	31,498	128,449
1868	71,343	....	71,343	74,763	9,124	83,887	(*)	155,230
1869	70,202	....	70,202	55,165	7,539	62,704	....	132,906
1870	67,954	....	67,954	82,612	8,848	91,460	....	159,414
1871	61,490	....	61,490	82,902	9,963	92,865	....	154,355
1872	51,608	....	51,608	87,403	10,144	97,547	....	149,155
1873	44,755	....	44,755	99,542	9,977	109,519	....	154,274
1874	39,108	....	39,108	68,490	9,800	78,290	....	117,398
1875	38,229	....	38,229	68,703	11,504	80,207	....	118,436
1876	39,116	....	39,116	77,314	10,488	87,802	....	126,918
1877	40,593	....	40,593	79,678	11,407	91,085	....	131,678
1878	39,700	....	39,700	71,560	14,987	86,547	....	126,247
1879	40,028	....	40,028	66,543	13,342	79,885	....	119,913
1880	38,408	....	38,408	64,935	12,603	77,538	....	115,946
1881	38,551	....	38,551	66,365	9,771	76,136	....	114,687
1882	32,802	....	32,802	67,014	10,848	77,862	....	110,664
1883	32,414	....	32,414	84,322	10,716	95,038	....	127,452
Total	6,746,456	53,959	6,800,415	5,947,315	767,475	6,714,790	1,549,101	15,064,306

* Included under cod fisheries since 1867.

TABLE XIII.—*Number and tonnage of vessels of the United States employed in the cod and mackerel fisheries June* 30, 1883.

State.	Customs district in which documented.	Vessels above 20 tons.		Vessels under 20 tons.		Total.	
		No.	Tons.	No.	Tons.	No.	Tons.
Maine	Passamaquoddy	115	13,368.25	24	301.56	139	13,669.81
	Machias	8	266.83	22	283.18	30	550.01
	Frenchman's Bay	27	1,385.58	32	346.15	59	1,731.73
	Castine	36	2,134.09	28	355.85	64	2,489.94
	Bangor	......	....	4	60.41	4	60.41
	Belfast	26	1,323.09	34	373.11	60	1,696.20
	Waldoborough	72	2,804.53	84	1,072.34	156	3,876.87
	Wiscasset	35	1,946.44	44	512.89	79	2,459.33
	Bath	1	31.00	11	113.17	12	144.17
	Portland and Falmouth	113	6,522.15	38	502.34	151	7,024.49
	Saco	1	31.30	6	53.79	7	85.09
	Kennebunk	6	189.70	11	113.15	17	302.85
	York	1	34.10	5	49.11	6	83.21
New Hampshire	Portsmouth	29	5,753.10	6	79.35	35	5,832.45
Massachusetts	Newburyport	10	331.24	9	94.29	19	425.53
	Gloucester	343	21,633.62	68	809.92	411	22,443.54
	Salem and Beverly	13	865.15	12	140.08	25	1,005.23
	Marblehead	21	1,111.09	16	179.47	37	1,290.56
	Boston and Charlestown	51	3,015.16	10	77.18	61	3,092.34
	Plymouth	9	606.61	14	139.58	23	746.19
	Barnstable	174	14,107.43	41	452.40	215	14,559.83
	Nantucket	......	....	11	68.10	11	68.10
	Edgartown	......	....	3	18.37	3	18.37
	New Bedford	9	608.00	45	466.37	54	1,074.37
	Fall River	3	131.11	17	211.99	20	343.10

TABLE XIII.—*Number and tonnage of vessels of the United States, &c.*—Continued.

State.	Customs district in which documented.	Vesels above 20 tons.		Vessels under 20 tons.		Total.	
		No.	Tons.	No.	Tons.	No.	Tons.
Rhode Island	Providence			42	333.07	42	333.07
	Bristol and Warren			4	34.24	4	34.24
	Newport	16	934.09	47	486.30	63	1,420.39
Connecticut	Stonington	25	993.88	40	409.25	65	1,403.13
	New London	28	1,193.12	34	457.09	62	1,650.21
New York	New York	18	851.65	106	714.12	124	1,565.77
	Sag Harbor			87	865.29	87	865.29
New Jersey	Little Egg Harbor	1	25.65	3	51.01	4	76.66
Maryland	Baltimore	34	1,222.00			34	1.222.00
Virginia	Tappahannock	6	246.17	30	285.20	36	531.37
North Carolina	New Berne	2	44.87	4	50.57	6	95.44
Florida	Pensacola	8	497.63	3	37.98	11	535.61
Alabama	Mobile	2	66.89	4	70.43	6	137.32
California	San Diego	2	46.33	4	42.40	6	88.73
	San Francisco			1	5.27	1	5.27

SUMMARY.

State.		Vesels above 20 tons No.	Tons.	Vessels under 20 tons No.	Tons.	Total No.	Tons.
Maine		441	30,037.06	343	4,137.05	784	34,174.11
New Hampshire		29	5,753.10	6	79.35	35	5,832.45
Massachusetts		633	42,409.41	246	2,657.75	879	45,067.16
Rhode Island		16	934.09	93	853.61	109	1,787.70
Connecticut		53	2,187.00	74	866.34	127	3,053.34
New York		18	851.65	193	1,579.41	211	2,431.06
New Jersey		1	25.65	3	51.01	4	76.66
Maryland		34	1,222.00			34	1,222.00
Virginia		6	246.17	30	285.20	36	531.37
North Carolina		2	44.87	4	50.57	6	95.44
Florida		8	497.63	3	37.98	11	535.61
Alabama		2	66.89	4	70.43	6	137.32
California		2	46.33	5	47.67	7	94.00
Total		1,245	84,321.85	1,004	10,716.37	2,249	95,038.22

TABLE XIV.—*Number and tonnage of vessels of the United States employed in the whale fisheries June* 30, 1883.

State.	Customs district in which documented.	Number.	Tons.
Massachusetts	Boston	5	794.87
	Barnstable	12	1,126.63
	Edgartown	5	891.28
	New Bedford (sail)	110	27,602.44
	New Bedford (steam)	3	1,298.39
Connecticut	New London	6	700.44
Total		141	32,414.05

VII.—ON THE FISHERIES OF GREAT BRITAIN AND THE FISHERIES EXHIBITION OF 1883.

By R. W. Duff, M. P.

[Abstract, by Chas. W. Smiley, of a lecture at Cullen, Scotland, January 3, 1883.]

The proposal to hold a great International Fisheries Exhibition in London was strengthened by the success which attended similar undertakings in Berlin, Norwich, and Edinburgh. These exhibitions were all extremely useful. They were the means of bringing valuable inventions before the public, and of suggesting improvements in important branches of fishing and maritime industry. They were also financially successful; in each case there were surpluses, ranging from £1,400 to £2,000. The Berlin Exposition was open only ten weeks; and in that time it was visited by 483,000 people. We propose to keep the London Exhibition open for six months. The population of London and the suburbs is now about 5,000,000; that of Berlin, only 1,100,000. We may therefore look forward to the number of our visitors running into millions.

The origin of the Exhibition was the result, in a great degree, of the success of the Norwich Exhibition. The proposal to promote a similar undertaking on a larger scale in London during the present year emanated from Mr. Birkbeck, M. P., and some members of the Fishmongers' Company of London. A preliminary meeting was held in the Fishmongers' Hall in July, 1881, when the Fishmongers' Company gave £500 to the prize fund and £2,000 to the guaranty fund, and appointed Mr. Birkbeck, who had acted with great ability as chairman of the Norwich Exhibition, to the chairmanship of the executive committee. That committee, limited to twelve, was composed of the representatives of the various fishery interests of the kingdom. The Marquis of Hamilton, as representing Ireland, and Sir A. T. Galt, as representing Canada, have since been added to the executive committee, while the duty of representing Scotland has devolved upon me. We succeeded in securing the support of royalty, Her Majesty the Queen graciously consenting to be patron, while the Prince of Wales became president, and the Duke of Edinburgh, our sailor prince, appropriately acting as our vice-president; the Duke of Richmond and Gordon, whose business abilities I am sure you all recognize, becoming chairman of our general committee. As foreign minister, Lord Granville offered us every assistance in bringing our project before foreign countries.

The Exhibition building stands on 23 acres of ground in the Horticultural Gardens, within three minutes' walk of a railway station. In

the open spaces in the gardens there will be fountains, large tanks containing various descriptions of live sea and fresh-water fish, full-sized fishing-boats, models of life-boats, including steam life-boats, full-sized fish-markets, and refrigerating vans for the conveyance of fish. In the covered space, extending over more than 300,000 square feet, will be shown the various exhibits, classed under seven different heads and sixty-one different divisions. In the building in which the Exhibition is to be held the committee have already authorized an expenditure of £20,000. We have a guaranty fund of £22,000. America is spending £10,000 on her exhibits; and, looking to the long list of foreign countries that are competing, at least £100,000 will be spent in what they are sending us. America, Canada, Newfoundland, Norway, Sweden, the Netherlands, and Belgium apply for an average of 10,000 square feet each for their exhibits; while China, Japan, India, Chili, and New South Wales take together 30,000 square feet. From the United States we may hope to learn a good deal about the artificial propagation of deep-sea fish. Canada and Newfoundland, as British fishing-grounds, are second to none. They possess a fishing coast of over 4,000 miles; and Sir A. Galt tells us that they produce £5,000,000 a year, and employ 90,000 men and boys. From an industry conducted on so large a scale we may expect to learn something, and possibly the mother country may be able to impart some knowledge to her promising and hardy sons on the other side of the Atlantic. An important fish trade has recently sprung up with the west coast of America. The canned fish trade with the Pacific coast has risen from 4,000 cases in 1866 to 928,000 cases in 1882. The total amount of salmon exported from the same quarter is 45,000,000 pounds.

In a part of the building set aside for the purpose will be shown in active operation the process of curing fish. I believe Scotland, Germany, and Holland are the chief competitors in this section. I have great doubt if anything in the shape of cured fish can be procured to compete with a kippered herring or a Finnan haddock. An effort will be made to introduce into the London market and make more popular what are termed the inferior classes of fish. Now, to appreciate the full importance of this subject I must ask you to bear in mind what an enormous place London has become. Including the suburbs it contains a population of five millions. Living within a radius of twelve miles you have a population nearly equal to the whole of that of Ireland, a third larger than the whole population of Scotland, and twelve times as large as the population of Glasgow. The amount of fish annually consumed in London is upwards of 130,000 tons, equal to 1,000 bullocks daily during the 313 working days of the year, and representing 90 pounds of fish per annum for every man, woman, and child in the metropolis. This large consumption has been attained in spite of the high railway rates and extremely defective market arrangements; but large as the present consumption of fish is, the demand goes on increasing,

and an opinion prevails that the demand might in some degree be met by educating the palate of the London fish consumer to appreciate what are known in the metropolitan market as the inferior classes of fish. We have enlisted the sympathies and secured the services of the managers of the School of Cookery at South Kensington; they have undertaken to cook and present in the cheapest and most palatable form at breakfasts and luncheons to be served in the Exhibition, dishes of the inferior fish. Now the importance of this will be understood when we look at the prices paid for first and second-class qualities in London. Following is a list of the average prices, taking all the year round, at Billingsgate: Sole, salmon, brill, gray mullet, John Dory, whiting, and eels average 1*s.* per pound; haddock, sprats, cod, herring, coalfish, plaice, ling, and hake on an average bring only 2*d.* per pound. Now nobody but a cockney would give six times the price for a sole or a whiting that he would for a haddock, or even a good fresh herring; but the fact is these second-class fish are not much known in the West End. By presenting them in a dainty form, we hope to show that they are not inferior to fish that command exorbitant prices, and if we can succeed in doing this we shall benefit alike the London fish consumers and the fishermen on the coast. Fifty per cent is the average deduction you have to make in this part of the country on your sales of fresh fish in London for railway rates and commission. Sometimes the whole proceeds of a sale are swallowed up by these two items, leaving absolutely no profit to the fishermen. The committee recommend that the railway commission be made permanent, and that on the application of traders the commission have power to order through rates; but this power is not to enable the commission to order lower rates than the limit at present charged. The railway commission is to hold sittings in Scotland. This is not a large concession, yet it might prevent the excessive rates; and although uniform rates are, in the opinion of the committee, impracticable, yet we look to the action of the commission to lower the rates and to diminish the anomalies, which a comparison of the rates in different localities at present presents. For instance, the Caledonia Railway charged four times the mileage between Montrose and Glasgow that it charged in through rates to London. Even the competition of sea traffic to London ought not to make so great a difference as this, and we may look to the action of the commission and the legislation that will follow the report of the committee for some measure of redress. The question of rates forms part of a subject for which the Exhibition committee offer a prize of £100 in the essay department.

Improved fishmarkets are needed in many places, but particularly in London. In Mr. Spencer Walpole's report to the Home Secretary in 1881 he mentions that in the seventeen months preceding December, 1880, 777 tons of fish were destroyed as being unfit for human food, and he attributes this loss in a great degree to the defective state of Billingsgate Market. Two-thirds of the fish that reaches the London market,

about 90,000 tons, are brought by train. As all of this fish has to be carted through the streets of London to Billingsgate, and then brought back again to the West End and distributed over a radius of 7 or 8 miles, it is not surprising that the proportion of condemned fish arriving by train is far higher than that brought by water. Of the 777 tons of fish I have mentioned as condemned, 615 tons were brought to London by train, as against 162 tons by water. This affords conclusive evidence of the necessity of a commodious fishmarket in one of the sites recommended by the engineer and architect of the metropolitan board of works in the immediate neighborhood of the termini of the great railways on the north side of London. So long as London was supplied with fish by water transit, Billingsgate might have sufficed; but now that two-thirds of the fish are brought by train, it is ridiculous to carry such a perishable article as fish through crowded thoroughfares where, according to Mr. Walpole, "the risk of the fish going bad is increased by the delays, constantly extending for hours, and occasionally extending over days, which are due to the inadequate approaches and want of room outside Billingsgate." Let Billingsgate remain as the market for water-borne fish, but let us have another market in the immediate vicinity of where the greater proportion of fish reaches the metropolis.

What is termed fish offal is in this district, I believe, usually sold at 1*s.* to 1*s.* 6*d.* a barrel for manure to the farmers, and by them very much prized; but the question arises, and it is one of some consequence to the fishermen and curers, are you making the best use of this offal? We know that isinglass, medicinal oil, glue, and guano can be made from parts of what are termed offal. Specimens of isinglass of the finest qualities from Nova Scotia were shown at the Edinburgh Exhibition. The utilization of fish offal is attracting considerable attention in Norway, and a grant was voted last year by the Norwegian Parliament to Mr. Sahlstorm, C. E., to carry on experiments in the utilization of fish offal. Mr. Sahlstorm is, I believe, the patentee of an invention for utilizing every portion of a fish. The flesh is converted into extract of fish, the liver into oil, the bones into isinglass, the heads into guano, and the skin into leather. Probably Norway, particularly at such places as the Loffoden Islands (an interesting account of the fisheries of which, and of the manufacture of cod-liver oil, is given in Du Chaillu's "Land of the Midnight Sun"), affords a better field for the particular industry I am referring to. But with better means of fishing I believe the fisheries off the Shetland Islands might be turned to more profitable account.

The first essay for which £100 is offered relates to the natural history of commercial sea-fishes. We require to know more about the food of sea-fishes, also at what age these fish become reproductive, and what localities particular fish frequent at different seasons of the year. A knowledge of these matters would be of great assistance to fishermen. Another essay is on the "Relation of the State to Fishermen and

Fisheries," including all matters relating to their protection and regulation. This would deal with home legislation, lights to be carried by fishing-boats, &c.; regulations for trawlers would also be included. The fishermen have gone so far as to propose to petition Parliament to abolish trawling altogether. Mr. Barclay, in addressing his constituents at Broughty Ferry, has showed that London and our other large towns were mainly dependent on the trawlers for supplies of fresh fish. He says that in London nine-tenths of the fish were trawled, but since 1866 the trawlers have gone on increasing in number, and the proportion of trawled fish that finds its way to the market must be still greater than that referred to by the commissioners. Most of the trawlers now use steam, and the direction we appear to be moving in is the greater application of steam power to all branches of our fishery industry. There is an important consideration which seems to have escaped the attention of those who advocate the abolition of trawling. They seem to overlook the fact that any regulations made by our Government are only binding within territorial waters, *i. e.*, within 3 miles of the shore. Supposing trawling abolished, or a close time for trawlers established, without an international convention the law could only be put in force against our own fishermen. This would simply be an inducement to Frenchmen, Dutchmen, and Norwegians to come and fish off our coast 3 miles from the land, and supply fish to London and other large towns after our own fishermen had been driven from the ground. At the same time I am decidedly of opinion that trawling should be carried on in a manner as little hurtful as possible to drift and line fishermen. The sea fisheries act of 1868, which was passed after we had entered into a convention with France, making the act binding on both nations, provides, "Trawl boats shall not commence fishing at a less distance than 3 miles from any boat fishing with drift-nets. If trawl boats have already shot their nets they must not come nearer to boats fishing with drift-nets than the distance above mentioned." Clause XIII. of the act protects line fishermen, as it is deemed an offense against the act if any one causes damage to the property of another sea-fishing boat. In 1881 another act was passed, entitled the "Clam and bait beds act." This gives the board of trade power, by provisional orders, to protect bait beds (within 3 miles of the shore) from injury by beam trawls. The order may be obtained on the application of the fishermen through a justice of the peace, a town council, or a rural sanitary authority. But there is another charge brought against trawlers; it is said they injure the fisheries by capturing immature fish, and that they destroy the spawn of fish. On this point the sea fisheries commissioners speak very decidedly. They say: "There is no evidence to show that trawling has permanently diminished the supply of fish from any trawling ground, but that there is proof to the contrary," and "we have sought in vain for any proof that the trawl brings up and destroys the spawn of fish." Another suggestion is that the mesh of the net used by trawl

ers should be larger, so as to allow immature fish to escape. This, like other regulations which apply to the open sea, could only be carried out by an international convention.

Money properly laid out in harbors should come under the head of reproductive expenditure. Take the case of Fraserburgh, £100,000 was borrowed at $3\frac{1}{4}$ per cent. In ten years the number of boats fishing from Fraserburgh was doubled, while in the same time the harbor revenue and the value of the exports were nearly trebled. If this is not reproductive expenditure, I fail to understand the meaning of the term; but at the present time it is impossible to obtain money on the terms that Fraserburgh borrowed it. Now, the committee invite essays to inquire into the reasons which have led the loan commissioners to raise the terms on which the money is lent for harbor improvements. Between the years 1861 and 1880—that is, from the date of the harbor and passing-tolls act till December, 1880—the public works loan commissioners lent for harbor purposes £2,781,820. During that period the losses, including principal and interest, only amounted to £16,434 and there is no single case given in the parliamentary return I am quoting from, where there has been any loss on money borrowed for Scotch harbor improvements. I am not saying there has been no loss to the revenue from money spent on Scotch harbors, but the losses—and they are comparatively insignificant when contrasted with those that have taken place in other parts of the Kingdom—have been in instances where special grants have been made, and not in those cases where the people have taken the initiative and borrowed money on harbor dues from the loan commissioners. I think inquiry into this matter will show that the commissioners have raised the rate of interest, in consequence of injudicious loans for other than harbor purposes. Hence the object of the harbor and passing-tolls act of 1861 has been defeated by Sir Stafford Northcote's act of 1879, and I think those interested have a right to ask that the borrowing powers conferred by the act of 1861 be restored to them. I attach importance to this, because I think it is by supplementing local efforts by money lent at the lowest possible rate of interest, that the Government can best encourage harbor improvements. The amount at the disposal of the fishery board, including £3,000 surplus brand money, given for the first time this year on the recommendation of the committee I had the honor of presiding over, only amounts to £6,000 annually. This money is at present being spent in the neighboring harbor of Findochtie, from the construction of which I hope you may derive some benefit. Another source from which we may look for some assistance in the construction of harbors is the employment of convict labor.

Very interesting experiments have been carried on at Peterhead and Aberdeen by pouring oil on the troubled waters at the entrances to the harbors. I have been able merely to read the accounts of those experiments, but they have excited considerable interest in the localities, and

Mr. Shields, the enterprising gentleman who has so energetically taken up this matter, will, I hope, be able to give us the result of his experience in the form of an essay.

An essay for which £25 is offered, is on the best means of increasing the supply of mussels and other mollusks (oysters excepted), used either for bait or food. Each individual fisherman in this district requires two tons of mussels annually for bait. Considering the importance fishermen attach to the easy supply of mussels, it is surprising that greater efforts have not been made to attain it. I have suggested, on previous occasions when speaking on this subject, that the Crown should buy up all the right of mussel proprietors where these rights exist. I believe in some cases they are claimed on very doubtful grounds. That mussel beds so acquired should be placed under the control of the fishery board, and let out to the fishermen. I believe a great deal might be done to increase the supply of mussels. To those who wish to read an interesting account of a mussel farm, I commend that given of the one at Aiguillon, by Mr. Bertram, in his interesting and valuable work, "The Harvest of the Sea."

Is there any ground for the statement we sometimes hear that the sea is being overfished? I believe investigation will prove that there is no cause for alarm. Although no doubt it can be shown that inland firths, and in some districts the sea near our coasts, are not so productive as formerly, yet in the open sea I believe it can be proved that our constant fishing has had no appreciable effect in diminishing the number of fish in the sea. By the railway returns it is shown that in the fourteen years between 1864 and 1878 we have increased by 50,000 tons annually the fish sent inland, while the herring fishing in 1880 was 73 per cent more productive than the average of the last ten years. With these facts before us, I should be sorry to see any attempt to put restriction on fishing by legislation, which it would be extremely difficult to enforce; and if Professor Huxley's calculation, that we do not by fishing take 5 per cent of the herring that are annually destroyed, is correct, I think we may leave the herring in full enjoyment of "home rule," and make no attempt to force any of our legislation upon them at present.

The power and influence of Great Britain depend on her naval supremacy. History teaches us that naval supremacy depends on a hardy and energetic seafaring population. It matters not how rich or powerful a nation may be, or how many ships she can put on the ocean, without seamen to man them she is powerless. What could the Spanish Armada, with all its ships, and soldiers, and sea-sick grandees, do against the little navy of Queen Elizabeth, skilfully handled by Drake and Hawkins, and manned by the hardy fishermen of Devon and Cornwall? It was the naval power of this country that subdued the First Napoleon; but, however great may have been the victories of Nelson, these victories would never have been achieved had he not commanded

real seamen. But although it is our navy that has given us security on the ocean, it is not alone to our men-of-war's men that our maritime supremacy is due. The mercantile marine of the Empire is represented by 8,500,000 tons of shipping. The whole of the rest of the world together has less than 13,000,000 tons. Our gigantic fleet of merchantmen conducts the most enormous commerce the world has ever known, having entered and cleared cargoes at ports in the United Kingdom from foreign countries and British possessions in 1880 of nearly 36,000,000 tons, the foreign trade to this country during the same period being represented by less than 14,000,000 tons. It was the power of our magnificent merchant fleet that enabled us, without disturbing our commerce, to transport in little over three weeks 46,000 men and 17,000 horses to the shores of Egypt, not the least remarkable part of our recent brilliant campaign. But if the maritime power of Great Britain excites the admiration rather than the jealousy of foreign nations, it is because that power has been exerted in the cause of freedom and in the cause of civilization. Our navy suppressed the slave trade; our merchantmen are the pioneers of commerce. Long may we continue to enjoy our strength and to exert it for noble purposes! But let us ever remember that the fisheries along our coast are the cradle of our seamen, the origin of our strength, and the source from which that strength is largely drawn.

VIII.—REVIEW OF THE WHALE FISHERY FOR 1882 AND 1883.

COMPILED BY CHAS. W. SMILEY.

[From the Whalemen's Shipping List, and Merchants' Transcript.]

THIRTY-NINTH ANNUAL REVIEW OF THE WHALE-FISHERY OF THE UNITED STATES.—The year 1882 passed away without any features of special note. Several vessels were lost at sea, mostly in different localities. The only loss of life was that of the officers and crew of the schooner Pilot's Bride, of New London. At home, the continued low price of sperm oil has discouraged those engaged in that branch of the business, and is fast leading to its discontinuance.

The present whaling fleet numbers 147, against 161 a year ago, of which number 105 are now at sea. Many of those in port are to be withdrawn for merchant service, while others have become too dilapidated to warrant repairs.

Sperm whaling during the past year has continued to droop, only 8 vessels having taken more than 500 barrels each, of which 4 cruised on the coast of Chili, and 4 in other localities. The owners, tired of small catches and ridiculously low prices, are changing their vessels to right-whaling or withdrawing them from the business. Indications point to an import of 20,000 barrels for the present year, and a probable reduction in the future. As the oil cannot be produced at a less cost than $1.25 per gallon, we cannot blame our merchants for transferring their time and capital to other enterprises.

Right-whaling has been prosecuted with fair success. Thirty vessels cruised in the Northern Pacific, averaging to each 767 barrels of oil and 11,730 pounds of whalebone, in addition to which they took on their between-season cruises an aggregate of 2,800 barrels of sperm, 750 barrels of whale oil, and 4,000 pounds of whalebone.

Two vessels were lost in the Arctic Ocean during the early part of the season by being crushed in the ice. If bad weather had not unexpectedly prevailed during the latter part of the season, the catch would have been much larger. Many additions are to be made to the fleet the coming year.

The southern right-whalers were fortunate, and fair catches were made on the Tristan grounds and other localities.

The consumption of different products is an interesting subject, and one that requires some attention. It has always been the custom to report as the consumption for the year, the amounts cleared from import markets by the refiners and manufacturers, regardless of the stocks the

latter were carrying at the close of the year. In accordance with this custom the report for the year 1881 showed a consumption of sperm oil in this country of 25,275 barrels, and in England of 3,000 tons, or 30,000 barrels, an aggregate of 55,000 barrels, when actually the large stocks in refiners' hands a year ago makes it probable that the actual consumption was not much in excess of 40,000 barrels.

Below is a carefully made statement of the estimated actual consumption for 1882:

		Barrels.
Crude sperm oil in importers' hands January 1, 1882		16,275
Crude sperm oil in refiners' hands in United States and England		16,300
Crude sperm oil imported into United States in 1882		29,875
Crude sperm oil imported into England from the colonies, &c		3,850
		66,300
Less stock in importers' hands January 1, 1883	20,100	
Less stock in refiners' hands in United States, and importers' and refiners' hands in England	6,000	
		26,100
Net consumption for the year		40,200

Whale oil is rapidly absorbed as soon as it arrives in market, and whalebone has been used during the past year to a greater extent than heretofore.

Sperm oil, from 95 cents at the commencement of the year, advanced steadily to $1.05 in February, $1.10 in April, $1.11 in July, and then gradually receded, touching 96 cents at the close of the year.

Whale oil from 53 cents in January, gradually advanced, touching 59 cents in September, and declining in December to 55 cents.

Whalebone opened the year at $1.40 and steadily advanced, touching $2.25 in October, and closing the year at $2.

The import of sperm oil for the year 1883 is estimated at 20,000 barrels, but that of whale oil or whalebone cannot be predicted, it being dependent on the success of the Arctic fleet.

The quantity of sperm oil at present on board the whaling fleet is 5,300 barrels, against 12,000 barrels a year ago, being the smallest amount known.

FORTIETH ANNUAL REVIEW OF THE WHALE-FISHERY OF THE UNITED STATES.—The year 1883 has been one of loss to those engaged in this business, and its results have been discouraging. The failure of the Arctic season, with small catches in other localities, has brought but small remuneration to those who risk their capital in the whale-fishery.

The fleet now numbers 125 vessels of all classes hailing from Atlantic ports, against 138 a year ago, and 19 from San Francisco, as against 8 last year. The number of vessels engaged in sperm whaling has been considerably decreased owing to the low prices of oil, while, on account of the value of whalebone, agents are inclined to send most of their ves-

sels to the Arctic Ocean and other right-whale regions. Indications point to a steady decrease in the number of vessels sailing from Atlantic ports, and perhaps a small increase in the number sailing from San Francisco for the Arctic Ocean.

A new feature of the past year, arising from the increase of Arctic whaling at San Francisco, has been the establishment of extensive works at that place for the manufacture and sale of whale and sperm oil, thus enabling the owners there located, as well as others who import oils at that place, to find a market without paying the heavy cost of shipping the same to the Atlantic sea-board. It is understood that the whole Arctic catch of oil, about 10,000 barrels, has been purchased at San Francisco at increased prices. Their works, in addition to large facilities for the manufacture of sperm candles, have a capacity of 150 barrels of oil per day, and are to be enlarged if the imports at that place and the sales of their products shall warrant.

Sperm whaling continues to decline, and no catches of any amount were made during the year except a few in the Atlantic Ocean and two or three off Patagonia. The number of ships and barks now in that fishery at sea is 48, most of which will follow right-whaling during half of the year. The continued low price of oil will soon prevent the business being followed to any great extent.

Right-whaling has been unfortunate, and the season in the North Pacific, owing to prevalence of ice and bad weather, was a failure. Thirty-eight vessels cruised there, 3 of which were lost, and the remaining 35 averaged 274 barrels of oil and 4,350 pounds of whalebone to each. The southern right-whalers were not as fortunate as in the previous year, and their general success was moderate.

The price of sperm oil, from 96 cents up per gallon on January 1st, rose to $1.05 in April and May, and from that time steadily declined, closing the year at 90 cents.

Whale oil, from 55 cents in January, continued at about the same price, with the exception of a rise to 59½ cents in April, until December, when, on account of the demand at San Francisco, it advanced, closing the year at 60 cents per gallon asked.

Whalebone opened the year at $2 per pound for Arctic, and, with a few variations, steadily advanced, until at the close of the year it sold at $4.75 per pound.

The purchases of sperm oil for consumption during the year have amounted to 32,200 barrels; the purchases of whale oil to 23,600 barrels, and of whalebone 376,000 pounds, all the above being bought at Atlantic ports, besides the purchases at San Francisco of all their importations, and quite an amount of oil and bone belonging to New Bedford vessels.

The import of sperm oil for 1884 is estimated at 18,000 to 19,000 barrels, but that of whale oil and whalebone must depend, as heretofore, on the success of the Arctic whaling fleet.

The figures of imports for 1883 do not include the oil and bone purchased at San Francisco, it being difficult at this distance to obtain the information with accuracy.

TABLE I.—*Importations of sperm oil, whale oil, and whalebone into the United States in 1882.*

	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
New Bedford	21, 276	16, 236	242, 099
Boston	300	20	....
Provincetown	1, 786	899	....
Edgartown	153	8	....
New York	6, 081	6, 168	29, 900
Portland	288	10	....
Salem	....	30	....
Total	29, 884	23, 371	271, 999

TABLE II.—*Stocks of oil and whalebone in the United States January 1, 1883.*

	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
New Bedford	19, 420	3, 675	170, 000
Provincetown	600	....	....
New York	80	....	....
Total	20, 100	3, 675	170, 000

TABLE III.—*Importations of sperm oil, whale oil, and whalebone into the United States in 1883.*

	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
New Bedford	17, 403	12, 272	107, 237
Boston	505	....	....
Provincetown	1, 431	427	....
Edgartown	1, 247	....	....
New London	....	841	3, 350
New York	4, 009	10, 630	143, 450
Total	24, 595	24, 170	254, 037

TABLE IV.—*Monthly statement of imports of sperm oil, whale oil, and whalebone in 1882.*

	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
January	1, 526	3, 250	18, 300
March	97	....	....
April	607	7, 662	1, 523
May	4, 723	3, 777	15, 168
June	1. 850	626	....
July	2, 336	186	4, 220
August	1, 692	916	3, 300
September	5, 902	1, 123	....
October	4, 492	1, 655	45, 067
November	3, 466	1, 233	....
December	3, 193	2, 943	184, 421
Total	29, 884	23, 371	271, 999

TABLE V.—*Monthly statement of imports of sperm oil, whale oil, and whalebone in 1883.*

	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
January	1, 243	2, 660	134, 387
February	733	....	....
April	963	4, 680	10, 086
May	2, 256	7, 554	5, 860
June	1, 204	149	....
July	2, 856	908	2, 851
August	517	553	18, 115
September	2, 851	2, 960	12, 903
October	9, 853	3, 283	3, 845
November	76	1, 083	....
December	2, 043	340	65, 990
Total	24, 595	24, 170	254, 037

TABLE VI.—*Number of vessels employed in the whale-fishery January 1, 1884.*

	Ships and barks.	Brigs.	Schooners.	Tons.
New Bedford	77	3	13	22, 877
Marion	....	....	1	80
District of New Bedford	77	3	14	22, 957
Edgartown	3	1	3	1, 297
Provincetown	....	1	11	1, 119
Boston	1	1	2	691
New London	....	....	6	812
Stonington	....	....	2	140
San Francisco	17	1	1	6, 103
Total January 1, 1884	98	7	39	33, 119

TABLE VII.—*Imports from 1853 to 1883, inclusive.*

Imports of—	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
1883	24, 595	24, 170	254, 037
1882	29, 884	23, 371	271, 999
1881	30, 598	31, 677	368, 322
1880	37, 614	34, 776	464, 028
1879	41, 308	23, 334	286, 280
1878	43, 508	33, 778	207, 259
1877	41, 119	27, 191	160, 220
1876	39, 811	33, 010	150, 628
1875	42, 617	34, 594	372, 303
1874	32, 203	37, 782	345, 560
1873	42, 053	40, 014	206, 396
1872	45, 201	31, 075	193, 793
1871	41, 534	75, 152	600, 655
1870	55, 183	72, 691	708, 365
1869	47, 936	85, 011	603, 606
1868	47, 174	65, 575	900, 850
1867	43, 433	89, 289	1, 001, 397
1866	36, 663	74, 302	920, 375
1865	33, 242	76, 238	619, 350
1864	64, 372	71, 863	760, 450
1863	65, 055	62, 974	488, 750
1862	55. 641	100, 478	763, 500
1861	68, 932	133, 717	1, 038, 450
1860	73, 708	140, 005	1, 337, 650
1859	91, 408	190, 411	1, 923, 850
1858	81, 941	182, 223	1, 540, 600
1857	78, 440	230, 941	2, 058, 900
1856	80, 941	197, 890	2, 592, 700
1855	52, 649	184, 015	2, 707, 500
1854	76, 696	319, 837	3, 445, 200
1853	103, 077	260, 114	5, 652, 300

TABLE VIII.—*Exports of sperm oil, whale oil, and whalebone from the United States for the last seventeen years.*

Imports of—	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
1883	13, 996	4, 543	175, 614
1882	13, 006	4, 421	175, 470
1881	15, 585	6, 457	106, 049
1880	12, 283	4, 395	171, 258
1879	11, 843	7, 374	75, 715
1878	32, 769	14, 371	86, 787
1877	18, 047	6, 390	70, 850
1876	23, 600	10, 300	133, 400
1875	22, 802	5, 424	205, 436
1874	18, 675	3, 300	164, 553
1873	16, 238	2, 153	120, 545
1872	24, 344	1, 528	177, 932
1871	22, 156	18, 141	387, 199
1870	22, 773	9, 872	347, 918
1869	18, 645	3, 842	311, 605
1868	18, 619	9, 885	707, 882
1867	25, 147	18, 253	717, 796

TABLE IX.—*Stock of oil and bone on hand the 1st of January for the last eighteen years.*

Imports of—	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
1884	13, 375	4, 250	50, 000
1883	20, 100	3, 675	170, 000
1782	16, 275	6, 150	285, 000
1881	27, 550	12, 950	225, 000
1880	16, 000	6, 425	109, 000
1879	9, 850	15, 350	82, 000
1878	10, 235	8, 500	85, 000
1877	8, 800	8, 200	27, 400
1876	7, 062	8, 110	168, 800
1875	4, 700	10, 800	145, 000
1874	12, 940	20, 675	165, 800
1873	11, 315	16, 695	235, 300
1872	14, 500	30, 000	293, 600
1871	28, 650	36, 000	400, 000
1870	25, 052	41, 633	294, 900
1869	13, 000	16, 700	200, 000
1868	8, 000	33, 400	274, 000
1867	12, 700	21, 200	172, 000

TABLE X.—*Statement of the average prices of sperm and whale oil and whalebone.*

	1882.			1883.		
	Sperm.	Whale.	Bone.	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*	*Barrels.*	*Barrels.*	*Pounds.*
January	96½	49	1. 41½	96	52	1. 92
February	1. 05	....	1. 38	1. 00	53	1. 90
March	1. 10	50	1. 45	1. 04	55	2. 20
April	....	50	1. 46	1. 05	56	2. 32
May	1. 10	52	1. 50	1. 05	53	2. 48
June	1. 10	52	1, 52	....	54	3. 25
July	1. 10	54	1. 63	95	54	3. 25
August	1. 10	56	1. 82½	95	52	3. 39
September	1. 10	57	2. 00	95	55	3. 39
October	1. 05	58	2. 10	92	55	3. 00
November	1. 03	58½	2. 25	92	53	....
December	98	53	2. 00	90	....	4. 43

Average price of sperm oil for 1882, 106 cents.
Average price of sperm oil for 1883, 97 cents.
Average price of whale oil for 1882, 53½ cents.
Average price of whale oil for 1883, 54 cents.
Average price of bone for 1882, $1.71.
Average price of bone for 1883, $2.87.

TABLE XI.—*Average price of oil and bone, 1848-1883.*

Year.	Sperm.	Whale.	Bone.
1883	$0 97	$0 54	$2 87
1882	1 06	53½	1 71
1881	88	48	1 63
1880	99	51	2 00
1879	84½	39	2 34
1878	91½	44	*2 46
1877	1 13	52	*2 50
1876	1 40½	61	*2 14
1875	1 60⅛	65¼	†1 12¾
1874	1 59	60½	1 10
1873	1 48	62	1 08
1872	1 45¼	65½	1 28½
1871	1 35	60	†70
1870	1 35½	67¼	85
1869	1 78	1 01¾	1 24
1868	1 92	82	1 02½
1867	2 23½	73¼	1 17½
1866	2 55	1 21	1 37
1865	2 25	1 45	1 71
1864	1 78	1 28	1 80
1863	1 61	95¼	1 53
1862	1 42½	59⅓	82
1861	1 31½	44¼	66
1860	1 41½	49⅛	80¼
1859	1 36¼	48½	....
1858	1 21	54	92¼
1857	1 28⅛	73¼	96¾
1856	1 62	79½	58
1855	1 77	71	45¼
1854	1 48¾	58⅝	39¼
1853	1 24¾	58⅛	34½
1852	1 23¾	68⅔	50⅓
1851	1 27¼	45¼	34½
1850	1 20½	49	34½
1849	1 09	40	31¾
1848	1 00⅛	33	....

*Currency. †Gold.

TABLE XII.—*Number of vessels and amount of tonnage employed in the whale-fishery since* 1850.

Year.	Ships and barks.	Brigs.	Schooners.	Tons.
January 1, 1884	98	7	39	33,119
January 1, 1883	101	8	38	34,137
January 1, 1882	105	10	46	35,892
January 1, 1881	116	11	50	39,426
January 1, 1880	119	11	48	39,433
January 1, 1879	124	12	50	40,602
January 1, 1878	129	11	47	41,197
January 1, 1877	121	8	43	37,828
January 1, 1876	123	7	39	38,883
January 1, 1875	119	8	36	37,733
January 1, 1874	130	7	34	41,191
January 1, 1873	153	12	38	47,996
January 1, 1872	172	12	34	52,701
January 1, 1871	216	18	54	69,372
January 1, 1870	218	22	81	73,137
January 1, 1869	223	25	88	74,512
January 1, 1868	223	17	89	74,596
January 1, 1867	222	10	80	75,340
January 1, 1866	199	8	56	68,535
January 1, 1865	226	7	43	79,696
January 1, 1864	258	5	41	88,785
January 1, 1863	301	10	42	103,146
January 1, 1862	372	10	41	125,462
January 1, 1861	459	14	41	158,745
January 1, 1860	508	19	42	176,848
January 1, 1859	561	19	45	195,119
January 1, 1858	587	18	49	203,141
January 1, 1857	593	22	40	204,202
January 1, 1856	585	21	29	199,149
January 1, 1855	584	20	34	199,846
January 1, 1854	602	28	38	208,399
January 1, 1853	599	30	32	206,286
January 1, 1852	558	27	35	193,990
January 1, 1851	502	24	27	171,971
January 1, 1850	510	20	13	171,484

TABLE XIII.—*North Pacific fishery.—Number of American ships engaged in the North Pacific fishery for the last twenty-four years, and the average quantity of oil taken.*

Year.	Number of ships.	Average production.	Total.
		Barrels.	
1860	121	518	62,678
1861	76	724	55,024
1862	32	610	19,525
1863	42	857	36,010
1864	68	522	35,490
1865	59	617	36,415
1866	95	598	56,925
1867	90	640	57,620
1868	61	708	43,230
1869	43	890	38,275
1870	46	1,069	49,205
1871	40	....	15,000
1872	27	729	19,680
1873	29	665	19,300
1874	22	915	20,120
1875	16	1,374	21,980
1876	8	656	5,250
1877	16	1,065	17,030
1878	17	770	13,080
1879	18	951	17,118
1880	19	1,421	27,000
1881	22	1,125	24,740
1882	30	767	23,025
1883	35	274	9,605

TABLE XIV.—*List of vessels comprising the North Pacific whaling fleet of* 1882.

Name of vessel.	Whale.	Bone.	Name of vessel.	Whale.	Bone.
NEW BEDFORD.					
	Barrels.	*Pounds.*		*Barrels.*	*Pounds.*
Abraham Barker	850	13,500	Rainbow	1,000	15,000
Arnolda	300	3,000	Reindeer*	350	3,200
Atlantic	650	11,000	Sappho‡	....	....
Belvedere	750	9,000	Stamboul	300	4,000
Eliza	350	6,000	Young Phœnix	225	3,800
Europa*	950	11,000			
Fleetwing	1,250	19,000	EDGARTOWN.		
Gazelle	200	3,000			
George and Susan	900	11,000	Bounding Billow	600	10,000
Helen Mar	800	11,000			
Hunter	*1,400	25,590	SAN FRANCISCO.		
Jacob A. Howland	600	9,000			
John Howland	1,750	29,500	Bowhead	1,650	26,000
Josephine	300	5,000	Coral	1,000	14,000
Louisa	400	6,000	Dawn	900	14,000
Mabel	700	10,500	Francis Palmer	350	5,000
Mary and Susan	1,050	20,500	Hidalgo	700	8,000
Northern Light	800	11,500	Sea Breeze and tender	1,309	34,500
North Star†	....	....			
Ohio, 2d	600	8,000	Total	22,975	360,500

* Japan Sea. † Lost July 8. ‡ Lost May 6.

TABLE XV.—*List of vessels comprising the North Pacific whaling fleet of* 1883.

Name of vessel.	Whale.	Bone.	Name of vessel.	Whale.	Bone.
NEW BEDFORD.	*Barrels.*	*Pounds.*		*Barrels.*	*Pounds.*
Abraham Barker	600	6,700	Stamboul	50	....
Arnolda	100	....	Young Phœnix	300	6,300
Atlantic	125	1,300			
Belvedere	500	8,000	SAN FRANCISCO.		
Europa*	650	5,500			
Fleetwing	275	3,900	Amethyst	100	1,500
Gazelle	140	5,900	Balæna	100	4,000
George and Susan	250	1,400	Bowhead	950	15,000
Helen Mar	90	1,400	Bounding Billow	240	3,300
Hunter	125	1,200	Coral	380	3,000
Jacob A. Howland	350	4,400	Cyane §	....	....
John Howland †	250	2,000	Dawn	100	1,400
Josephine	330	5,500	Eliza	375	6,000
Louisa ‡	300	5,000	Francis Palmer	....	....
Lucretia	125	1,500	Hidalgo	....	....
Mabel	240	4,500	Narwhal	430	6,000
Mary and Helen	380	4,500	Orca	1,300	20,500
Mary and Susan	200	3,500	Sea Breeze	150	1,800
Northern Light *	325	5,000	Wanderer	125	1,900
Ohio, 2d	350	7,000			
Rainbow	450	7,000	Total	10,155	159,400
Reindeer *	400	3,500			

* Japan Sea. † Lost July 17. ‡ Lost September 22. § Lost August —.

TABLE XVI.—*Stocks of oil and whalebone in the United States January* 1, 1884.

	Sperm.	Whale.	Bone.
	Barrels.	*Barrels.*	*Pounds.*
New Bedford	13,375	4,250	50,000

TABLE XVII.—*List of whalers expected to arrive in* 1884, *with the quantity of oil and bone on board when last heard from.*

Name of vessel.	Sperm.	Whale.	Name of vessel.	Sperm.	Whale.
NEW BEDFORD.					
Adelia Chase	....	....	Kathleen	....	....
Adeline Gibbs	300	....	Milton	545	300
Alice Knowles	....	....	Ospray	....	....
Alaska	410	70	Palmetto	650	....
Commodore Morris	....	....	Petrel	160	400
Europa	150	650	President, 2d	460	75
George and Mary	....	....	Sea Ranger	....	....
Golden City	....	....			

TABLE XVIII.—*Importations for 1882, showing the date of arrival, and the amount of oil and whalebone brought by each vessel.*

Date.			Sperm.	Whale.	Bone.
1882.			*Barrels.*	*Barrels.*	*Pounds.*
Jan.	3	Acapulco, New York	380	2, 150	11, 000
	6	E. Hatton, New York	998		
	23	Western Texas, New York	63		
	27	Colon, New York	85	1, 100	7, 300
			1, 526	3, 250	18, 300
Mar.	16	City of Para, New York	97		
			97		
Apr.	2	Lottie E. Cook, New Bedford		133	1, 523
	7	Veronica, New Bedford	156		
	17	Mary S. Ames, New Bedford		5, 352	
		Progress, New Bedford		1, 418	
		Progress, New Bedford, on freight		618	
	20	Platina, New Bedford	451	141	
			607	7, 662	1, 523
May	1	Sea Fox, New Bedford	468		
		Sea Fox, New Bedford, on freight	21		
	2	State of Texas, New York	138		
		L. A. Roby, Salem		30	
	17	Morning Star, New Bedford	124		
		Morning Star, New Bedford, on freight	386	416	2, 530
		Lottie Beard, New Bedford	1, 849	342	3, 948
	23	Wanderer, New Bedford	608	680	
	26	Sunbeam, New Bedford	261	865	690
	29	Niger, New Bedford	769	1, 159	4, 200
		Niger, New Bedford, on freight	99	285	3, 800
			4, 723	3, 777	15, 168
June	5	Ino, New Bedford	1, 045	454	
	15	City of Para, New York	99	39	
	25	Colon, New York	418	48	
	30	Bermuda, New York		75	
	30	Hyaline, Portland	288	10	
			1, 850	626	
July	2	Acapulco, New York	230		
	13	Veronica, New Bedford	380		
	16	City of Para, New York	40		
	24	Colon, New York	283		
	28	Napoleon, New Bedford	1, 175	186	
		Napoleon, New Bedford, on freight	228		4, 220
			2, 336	186	4, 220
Aug.	2	Rising Sun, Provincetown	211	152	
	7	Wave, New Bedford	446	2	
		E. Rizpah, Provincetown	218	142	
	18	E. H. Hatfield, Edgartown	153	8	
	21	Agate, Provincetown	169	206	
	22	Falcon, New Bedford	495	406	3, 300
			1, 692	916	3, 300
Sept.	4	M. G. Curren, Provincetown	353	168	
	13	Ocean, New Bedford	612	123	
	14	Swallow, New Bedford	765	164	
		Admiral Blake, New Bedford	148		
	15	Acapulco, New York		240	
	18	Golden City, New Bedford	23	26	
	20	E. H. Adams, New Bedford	84		
	21	Quickstep, Provincetown	136	3	
	22	F. A. Barstow, New Bedford	415		
		V. H. Hill, New Bedford	205	5	
		Ad. De Ruyter, New Bedford	673		
	23	James Arnold, New Bedford	1, 350	140	
		James Arnold, New Bedford, on freight	286	226	
		D. A. Small, Provincetown	300		
	25	Gay Head, New Bedford	79	2	
		Gay Head, New Bedford, on freight	74		
	26	Antarctic, Provincetown	99	26	
	27	William A. Grozier, Provincetown	300		
			5, 902	1, 123	

TABLE XVIII.—*Importations for 1882, &c.*—Continued.

Date.		Sperm.	Whale.	Bone.
1882.		*Barrels.*	*Barrels.*	*Pounds.*
Oct. 2	San Blas, New York	186	1,013	
3	General McClellan, New York	506		600
	George and Mary, New Bedford		216	3,414
	William Martin, Boston	210		
6	S. E. Lewis, Boston	90	20	
11	Per railroad			41,053
12	Bloomer, Provincetown		202	
15	Oronoco, New York	190		
23	Sarah, New Bedford	716	9	
29	Veronica, New Bedford	1,961		
	Mermaid, New Bedford	405		
	E. B. Conwell, New Bedford	228	195	
		4,492	1,655	45,067
Nov. 9	Canton, New Bedford	1,554		
15	City of Para, New York	1,912	1,233	
		3,466	1,233	
Dec. 4	Stallknecht, New Bedford	2,264	1,130	6,521
10	Lottie Beard, New Bedford	473	1,543	535
14	David Crockett, New York	235		
15	City of Para, New York	75	270	
26	Acapulco, New York			11,000
27	Western Texas, New York	146		
	By railroad, New Bedford			166,365
		3,193	2,943	184,421

TABLE XIX.—*Importations for 1883, showing the date of arrival and the amount of oil and whalebone brought by each vessel.*

Date.		Sperm.	Whale.	Bone.
1883.		*Barrels.*	*Barrels.*	*Pounds.*
Jan. 1	Carondelet, New York	196		
3	San Blas, New York	207	973	
	Clara Fletcher, New Bedford	259		
12	Western Texas, New York	53		
15	City of Para, New York	277	789	17,000
	By railroad, New York			100,000
	By railroad, New Bedford			11,887
26	Acapulco, New York	159	898	5,500
31	Sarah, Boston	92		
		1,243	2,660	134,387
Feb. 8	Veronica	733		
		773		
April 13	C. Adams, New York	199	2,828	
14	Lottie E. Cook, New Bedford		90	900
	Bertha, New Bedford	274	191	2,041
17	Francis Allyn, New London		485	
26	Alice Knowles, New Bedford	448	987	7,145
27	Bermuda, New York	42	99	
		963	4,680	10,086
May 4	Grayhound, New Bedford	111	393	
8	Charter Oak, New Bedford	267	3,953	
24	A. R. Tucker, New Bedford	22	90	
25	John Carver, New Bedford	496	135	
30	Lottie Beard, New Bedford	1,360	983	5,860
		2,256	7,554	5,860
June 1	Ruby, New York	198	64	
3	Stafford, New Bedford	390	3	
11	Tropic Bird, New Bedford	25		
20	E. Rizpah, Provincetown	81	82	
25	Acapulco, New York	428		
29	Gem, New York	82		
		1,204	149	

TABLE XIX.—*Importations for* 1883, *&c.*—Continued.

Date			Sperm.	Whale.	Bone.
1883			*Barrels.*	*Barrels.*	*Pounds.*
July	7	Eliza Adams, New Bedford	1,010	353	1,121
	16	Audrew Hicks, New Bedford	387	22	....
	18	Jireh Perry, New Bedford	534	446	1,730
		Veronica, New Bedford	201	35	....
	24	William Wilson, New Bedford	179	6	....
	27	Antarctic, Provincetown	357	23	....
	28	George W. Clyde, New York	....	23	....
	29	Sarah, Boston	188	....	....
			2,856	908	2,851
Aug.	10	Agate, New Bedford	143	243	965
	18	Adelaide, New Bedford	....	196	....
	20	Bloomer, Provincetown	59	92	....
	26	Charles W. Morse, New Bedford	315	22	....
		By railroad, New Bedford	....	....	3,600
		By railroad, New York	....	....	13,550
			517	553	18,115
Sept.	1	G. H. Phillips, Provincetown	185	23	....
	3	Crown Point, Provincetown	134	131	....
	4	Era, New London	....	119	1,850
		Era, New London, on freight	....	237	1,500
	7	M. G. Curren, New Bedford	201	292	....
	9	Franklin, New Bedford	250	4	....
	10	E. Rizpah, Provincetown	39	....	....
	12	R. Sun, New Bedford	20	225	....
	13	Valparaiso, New York	....	1,440	....
	14	Quickstep, Provincetown	172	76	....
		Isabella, New Bedford	....	372	5,000
		Seine, New Bedford	538	....	....
	16	Union, New Bedford	108	35	....
	18	S. E. Lewis, Boston	225	....	....
	23	Emma Jane, Edgartown	152	....	....
	24	Railroad, New Bedford	....	....	4,553
	26	H. E. Smith, Edgartown	195	....	....
		Alcyone, Provincetown	364	....	....
	27	M. E. Simmons, New Bedford	228	6	....
			2,851	2,960	12,903
Oct.	4	A. Bradford, New Bedford	....	154	2,300
	5	Colon, New York	1,060	....	....
	8	Seina, New York	222	....	....
	10	Young America, New York	118	....	....
	14	Moro Castle, New Bedford	2,438	619	1,545
	15	Pedro Varela, New Bedford	306	2	....
		City of Para, New York	95	1,124	....
	18	Veronica, New Bedford	2,166	75	....
		Mary Frazier, Edgartown	900	....	....
	25	Crescent City, New York	232	550	....
	26	Acapulco, New York	70	750	....
		General McClellan, New York	295	....	....
	27	Sarah, New Bedford	1,974	....	....
			9,853	3,283	3,845
Nov.	3	Colon, New York	38	358	....
	15	City of Para, New York	38	725	....
			76	1,083	....
Dec.	15	City of Para, New York	133	....	....
		By railroad, New York	....	....	7,400
	18	Lottie Beard, New Bedford	1,910	349	....
		By railroad, New Bedford	....	....	58,590
			2,043	340	65,990

IX.—SVEND FOYN'S WHALING ESTABLISHMENT.*

In the remote northeastern part of our continent, where the White Sea and the Polar Sea meet, lies Vadsoe, a miserable little town, with about 1,800 inhabitants, scarcely one-half of whom are civilized Europeans, for upwards of 900 are Laplanders and Finns. The town is divided into two distinct parts, according to the character of the population. It extends for a considerable distance along the coast, and one part consists of dark log-houses covered with turf, such as are frequently seen beyond the arctic circle, while the part inhabited by the Europeans is built up more closely and has a more cheerful look. In strolling through the streets and alleys of Vadsoe we meet with many strange and characteristic figures. Russians, Finns, Laplanders, and Norwegians mingle in the streets; and this mixture of different nationalities gives a peculiar character to the little town. Here is the small Laplander in his gaudy costume and his soft, cat-like walk. The Russian is generally dirty and seedy in his appearance, with a nose indicating deep and frequent potations of strong whiskey, and with his long hair hanging wildly about his forehead; and towering above all the rest, like a lord and master, is the tall and well-made Norwegian, with his blonde hair and Teutonic features.

The most important person in the whole town of Vadsoe—more important even than the mayor—is Svend Foyn, an old whaler; and it is to him and his whaling establishment that I now desire to introduce my readers.

Fish and whales are the principal sources of income in this country, and as all the fisheries are free, every one endeavors to earn his living thereby. This was also the case with Svend Foyn, who in his youth was a simple whaler, and now carries on the whaling business on an extensive scale. His establishment is located on the coast opposite Vadsoe, and occupies a considerable space. The nearer our boat approached it, the more unendurable became the odor arising from it. When we approached Vadsoe by steamer and the establishment was pointed out to us, our attention had been attracted by some large white hills on the shore whose nature we could not understand; now, however, it became clear to us that these hills were whales undergoing the process of manufacture. At a short distance from the establishment a large

* *Svend Foyn's Walfisch-Etablissement.* From the *Deutsche Fischerei-Zeitung*, Vol. VI, Nos. 47 and 48, Stettin, November 20 and 27, 1883. Translated from the German by HERMAN JACOBSON.

object rose from the water, which at first we took to be a small island or rock, although we had passed the region of the innumerable rocky islands which line the northern and western coasts of Norway. When we came nearer we found that it was a large whale, which had been killed only a few hours before. We must confess that the enormous dimensions of this animal exceeded all our expectations It measured almost 60 feet in length, and was correspondingly thick; its head and tail were under water, and only the body proper, like an oval cut lengthwise, rose from the sea, whose waves were washing it. We rowed entirely around the whale. It was in every sense of the word a monster; for even the largest land animal known, the elephant, seemed a dwarf when compared with it. Firmly anchored, it awaited its fate. We now rowed to the wharf which extends in front of the establishment. On this wharf stood an old man, the master himself, Svend Foyn, as our boatman told us reverently. We landed, but the ascent offered considerable difficulties. The steep stairs had no railing, and were covered to the depth of several inches with mud, which, mixed with fat, had become a compact and slippery mass.

When we had accomplished the dangerous ascent, we were met by Svend Foyn himself. Truly he presented a most remarkable figure. He was a stout, short man, whose body, in spite of his age, showed strength and flexibility. He was clad in wide flowing garments of a blue color, almost giving him the appearance of a ball; under the broad-brimmed black hat there was a head covered with snow-white hair, but with a pair of bright blue eyes revealing great intelligence. The one of our number who was something of a polyglot addressed to him in Danish a request to allow us to visit his establishment. We had first to undergo a long examination. He wanted to know who we were, whence we came, our names, and where we were going. Only after we had told him that the American among our number was a clergyman, that the other two were Germans, one of them a geographer and the other a lawyer, did he consent, but not until we had assured him that we had not been sent by other whalers to study the secrets of his "manufacture." After we had solemnly assured him that this was not our object, he nodded assent, and the audience with the king of whalers had come to an end.

We now took a survey from the bridge. The white hills on our right and left were actually whales which had been skinned. There were at least from six to eight of them, from the fresh whale, perhaps caught only yesterday, to those which had been lying here from eight to fourteen days, and which, having been continually exposed to the rays of the sun, emitted a very strong odor. Some of them measured sixty feet in length, veritable monsters, which, half floating in the water and half drawn ashore, presented a horrible spectacle. Wherever there was any fat they looked white, and where the flesh had been cut they appeared red, in all imaginable shades and colors. The sight was one which required strong nerves. About a dozen workmen were busy with these whales

engaged in various manipulations. Pieces of fat two and three times the length of a man were cut from the large animals and simply thrown into the water (the workmen partly stand on the whales) and drawn ashore with large hooks. Large quantities of whalebone were lying about on the shore, and I would like to have seen the expression of one of our fashionable ladies when viewing this whalebone and thinking of the delicate pieces of the same material in a prepared condition destined to give a slender appearance to her waist. No doubt she would have characterized this sight as simply horrible.

In a large shed the whales are cut to pieces. After all the fat has been removed they are floated to the shed and hoisted up by means of a windlass on an inclined plane. Here the dissecting process begins. The flesh which still remains is cut off to serve as guano, and the bones are taken out and crushed, to become a fertilizer. Prior to this, however, the entrails are removed—the only part which is of no use—tied together with ropes, and laid at anchor in the harbor till a sufficient quantity has accumulated. Then a steamer takes them in tow and sails out into the open Polar Sea, where they are loosened from the steamer and left to serve as delicious food for different fish.

We wandered farther, again on *terra firma*, which, however, was anything but firm. Supporting ourselves with our umbrellas, we slowly slid forward, carefully placing one foot before the other. Woe unto him who fell as he would inevitably be lost. All the roads leading through the establishment, which has almost the appearance of a small town, were completely soaked with train-oil and grease. To "step into train-oil"—a proverbial phrase with us—is here not only possible, but even pardonable. It might happen to any one of our number, for we were literally wading in a mire of dirt and grease.

We first visited the train-oil warehouse, where about 1,000 barrels of train-oil were stowed away; and thence we went to the guano factory. Here all the meat—everything which is not fat—is turned to guano, by being dried and pulverized. The residue of the fat which has been fried out is likewise utilized in this manner. From here we went into the bone-mill, where the bones are crushed to powder; and finally we visited the trying-house, which was one of the principal objects of interest. It is an enormously long building, or rather shed, having a roof to keep out the rain, its floor being below the surface of the ground and resembling a cellar. In this cellar many small fires were burning, which make the ceiling very warm. The entire building forms one large room or hall; on the warm floor lies the fat, cut into innumerable small pieces and piled up to the height of 2 or 3 feet. The whole mass of fat is seething and bubbling, and every now and then a man stirs it with a large shovel and turns it upside down; but the smell! Along one side of the building, whose floor slightly slants in that direction, there runs a trough into which the train-oil flows, and which conducts it to large basins, where it is rectified. More we did not wish, and actually were

not able, to see; for about an hour we had wandered about through all this dirt, grease, and foul odor, and now we had to say *satis superque* (enough and more than enough). We were truly thankful when, after having slid back over all these dangerous ὑγρὰ κέλευθα (watery ways), we sat again in our boat, which took us back to the steamer. To honest Svend Foyn we hereby express our deepfelt gratitude for having given us permission to visit his establishment; we shall not betray any of his secrets, and cheerfully leave him sole possessor of his "filthy lucre;" in spite of the horrible smell he doubtless thinks *non olet* (it smells not).

After we had gone about a hundred paces from the factory we noticed a small steamer, painted green, which was slowly approaching the shore. Its shape was very peculiar; it was small and short, exceedingly dirty and greasy, without masts, and instead of the prow it had a large board shaped like the top of a table. It was one of the vessels which catch whales. Svend Foyn has four of these steamers, which, during all summer, excepting the close season, cruise day and night in the Polar Sea. Their whole arrangement is peculiar in every respect. As we have said, they are not very large, scarcely from 50 to 60 feet long, and have powerful engines, which can propel the steamer at a rapid rate both backward and forward. There is no room for any cargo, only for the engine, for coal, and for the crew, which comprises from 6 to 8 men. It has no masts and prow, and therefore no rigging, and is really nothing but a hull. The board referred to above lies entirely free, so that from it an unobstructed view is obtained both towards the right and the left. On it there is a gun on a movable carriage. It is loaded with a harpoon, whose pointed head protrudes from the mouth of the gun, and to which is attached a long rope, which is wound on a roller.

X.—THE GREAT HERRING FISHERIES CONSIDERED FROM AN ECONOMICAL POINT OF VIEW.*

By Axel Vilhelm Ljungman.

The fame and importance of the great herring-fisheries make them worthy of becoming the subject of scientific treatment from an economic point of view. But as most writers on political economy have not occupied themselves with the sea fisheries, any attempt to say something on the economic significance of these fisheries meets with great difficulty. It is necessary, however, in order to fathom the actual importance of these fisheries. I have therefore gathered some data which may assist the solution of this question, which has hitherto been somewhat neglected.

I must first give some explanations of technical terms and speak of the difference between coast fisheries and high-sea fisheries. These terms are frequently employed, but most persons use them without having a correct idea wherein consists the difference between these two principal methods of fishing.

Coast fisheries may be carried on near the coast or at some distance from it. Their characteristic feature is that the fisherman every day carries the fish he has caught to the port where he lives, and where the fish are sold, either for immediate consumption or for being manufactured into an article of merchandise.

In the high-sea fisheries, which, as the name implies, are invariably carried on at a considerable distance from the coast, the fishermen are compelled to keep the fish on board their vessels for several days, or prepare them out at sea.

It is evident that the difference between these two methods of fishing is of very great importance as regards the quality of the prepared fish. In a small fishing vessel there are not the same facilities for preparing the fish as in a spacious establishment on shore. The owner cannot superintend the preparation on board as well as he can do it at home in his salt-house. The consequence is that the preparation on board a fishing vessel out at sea, especially when a large quantity of fish is

* *Om de stora sillfiskena, betraktade från nationalekonomisk synpunkt.* A paper read before the Swedish Economic Society, February 26, 1883. Translated from the Swedish by Herman Jacobson.

to be prepared, will rarely be as careful as on shore, if the herring are brought home in good time. This is the reason why the Scotch fisheries, which are principally coast fisheries, furnish the best herring which are in the market at the present time. Coast fisheries also have the advantage that fewer hands are needed on board the fishing vessel. No large and heavy boats are required, nor is there any necessity for an expensive equipment, and thus greater results are reached with less capital. One of the disadvantages of the coast fisheries is that the fishermen cannot follow the migrations of the fish as well as in the high-sea fisheries, but in most respects the advantage is on the side of the coast fisheries; and, as matters stand at the present time, the high-sea herring-fisheries offer such great difficulties that in many places the idea of introducing them had to be abandoned. This does not, however, prevent the high-sea herring-fisheries from yielding a good income under certain circumstances.

As well-known illustrations of these two different kinds of fisheries, we may mention, among coast fisheries, the Norwegian and Scotch herring-fisheries, and the great Loffenden cod-fisheries; and among high-sea fisheries, the Dutch so-called "great" herring-fisheries, and the Dutch, French, and Swedish bank fisheries in the North Sea. Of late years a new and remarkable form of high-sea fisheries has developed with unusual rapidity, viz, the beam trawl-net fisheries for bottom fish on the large banks in the North Sea, which yields rich results.

Another circumstance which is of importance in this connection is the employment of different fishing apparatus in the service of private capital. Wealthy firms or associations send out entire fishing fleets, and carry on the fisheries with hired men; while, on the other hand, there are fishermen who carry on their business with their own vessels and apparatus. It is evident that the first-mentioned method of carrying on the fisheries, such as the great fisheries proper, which are worked by men who can at any time be discharged by the owners of the vessels, is neither from a social nor an economic point of view so beneficial to the fishing population as those fisheries where the fishermen own their material and carry on their business in an independent manner. The so-called great fisheries can, therefore, in their social aspect, not be compared with those fisheries which are in the service of small capital. On the coast of Bohuslän, for example, the high-sea fisheries are carried on in such a manner that the fishermen own their vessels; and when one of them becomes feeble, he furnishes another man, who, for half the income, carries on the fisheries in his place. The same also takes place in case of death, when the family which is left behind has a part of the income derived from the deceased person's share in the fishing vessel; and an energetic man, even if he owns only half a share, can gradually earn enough to enable him to buy a whole share. The "great" fisheries, on the other hand, especially in England, meet with many obstacles, more particularly of late years, after more liberal laws

have been made, as the owners of vessels find great trouble in getting the necessary crews for their vessels. It has become a common occurrence for the hired fishermen suddenly to leave the vessel. A special commission, which met last year, was informed by a large firm in Yarmouth that the number of desertions from their vessels reached 1,000 in little more than a year. It is also evident that a hired crew cannot take the same interest in the business as men who carry it on on their own account. It is true that recently attempts have been made to improve matters by giving the crew a certain share of the fish in addition to their regular wages. This, of course, is a considerable incentive; but, on the other hand, fishermen, more than most other laborers, are inclined to be independent, and they do not like to subordinate themselves to the strict order and discipline which must be maintained on the vessels of the large fishing fleets, and which, of course, do not prevail to such an extent on the vessels of independent fishermen. In America a better method has been found for managing the business in this respect. There the wealthy firm which owns the vessel places it at the disposal of a set of fishermen, who carry on the fisheries on their own account and receive a certain share of the fish.

The Dutch high-sea fisheries, as is well known, early developed the custom that rich firms or associations should own the fishing vessels and carry on the fisheries with hired men. The Dutch high-sea fisheries have, therefore, from the very beginning, become "great" fisheries. In Holland it has thus always been considered necessary that when a new fishing vessel was fitted out, some suitable person should be selected who could be placed in charge of the expedition. It depends entirely on his ability to maintain discipline and superintend the preparation of the fish whether the enterprise will prove successful. If he cannot do this, the enterprise will not pay. This manner of carrying on the fisheries, however, depends on a good market for the fish, and on the circumstance whether capital can be found which cannot be put to any better use, and whether suitable men can be obtained who will serve on such fishing vessels, for this service is exceedingly trying and anything but pleasant.

As regards the availability of capital for the fishing trade in general, money is usually forthcoming only too quickly, especially at the beginning of a new fishing period, when people imagine there is a rare chance for making much money in a short time. People will hastily invest a large amount of capital in enterprises before they possess a sufficient knowledge of their character. This causes losses, and people become afraid to invest any more, and the trade suffers. Capital is probably used to the greatest advantage when it is furnished as a loan to competent and energetic men whose character and experience furnish a sufficient guaranty that the enterprise will pay.

The "great" fisheries in the service of vast capital are exclusively carried on by cities, as they alone can start and carry on such enter-

prises with any hope of success. Also, for the fishing trade in general, cities offer great and important advantages, for, in the first place, it will be easier in a place having a population of from 8,000 to 10,000 or more to unite men in measures for advancing the fishing trade than in a village where, even if the population be as large, it is scattered along a great extent of coast. Cities, moreover, possess greater facilities in the matter of postal and telegraph service, better means of communication, and thereby a better chance for disposing of the products of their fisheries. Another great advantage offered by cities are banks. The great herring fisheries depend to a great extent on the circumstance that the manufacturers of prepared fish have access to banks to manage their financial transactions. They need some one to advance to them considerable capital, and the banks can do this. Thus, in Scotland a considerable portion of the fish are paid for, by way of an advance of capital, almost a year before they are ready for the market. Money is also needed for buying material, for paying wages, for paying insurance, &c.; and when the sale of fish takes place these banks attend to the collecting of the money. In Scotland, previous to recent changes, sales were to a great extent made in such a manner that, after the herring were shipped, the sender, by surrendering bills over the crown-stamped herring, the insurance, and the freight, through the local bank, drew a check on a London bank where the buyer had credit, and in that manner got his money immediately. This manner of effecting sales made it common for bankers to loan money on crown-stamped herring which were consigned to some continental port, and this had the great advantage for the Scotch herring-fisheries that they could quickly exchange their fish for money, which otherwise would not have been possible. A bank transacting such business, of course, besides its fees, has the advantage that the savings are placed in it, and the fishermen find this more advantageous to themselves than to place the money in small quantities here and there, as is often done on the coast of Sweden.

In Bohuslän the scattering of the fishing trade, which dates far back, has been the principal reason why the well-being of the population has declined whenever a herring-fishery period came to a close, of which we have a sad example from the year 1809, when the last herring period ended. The population of a city will always find it easier in such a crisis to turn to some other business. This becomes very evident when we examine the state of affairs prevailing in Norway. There, too, the herring have at different periods ceased to come, but as the fishing trade was concentrated in cities like Bergen, Stavanger, &c., the population found it easy to turn to some other employment, and even to other fisheries. Many of the persons engaged in the fisheries were enabled to work their way into the shipping business; and to this circumstance it is principally owing that Norway at the present time has so large a mercantile marine.

As regards the preparation of the herring, it is particularly important that it should be done in a city, as the different salters of one and the same city act as a check upon each other. If one of them makes a mistake, it becomes known. Such matters cannot be concealed in a city with the same ease as in an isolated establishment on the coast. The places where herring are being prepared are, moreover, often visited by the agents of the herring-dealers, and they are better able to exercise a strict control over the preparation of the herring and their quality in a city than if they are obliged, within a limited period of time, to travel from one salt-house to another along a vast extent of coast. This circumstance has also aided in making the Scotch herring famous, because they are almost exclusively prepared in cities. This was early recognized in Scotland, and during the last century the question was agitated of encouraging the formation of fishing towns by granting large prizes, as the idea prevailed at the time that there was no better way of encouraging the fishing trade than by granting prizes.

It is also evident that the fisheries are carried on to greater advantage by persons who uninterruptedly and exclusively devote themselves thereto than by those whose interest in the fisheries is, so to speak, accidental. When, however, a fishery is secularly periodical, as, for instance, the Bohuslän herring-fisheries and the Norwegian spring-herring fisheries, it may be advantageous if others than professional fishermen take a part in the fisheries. Otherwise they could not be carried on to a sufficient extent during the comparatively short duration of the herring period. The circumstance that others than professional fishermen devote themselves to the fisheries may, however, prove injurious to other trades if these are to a great extent neglected, and if people wish to live entirely by the income from the periodical fisheries. Thus it happened during the great Bohuslän herring-fisheries of the eighteenth century. In a short time people earned what they needed for the whole year, and the consequence was that other, and, on the whole, more important, trades were neglected. It is hardly to be supposed that this will take place to the same extent during the present herring period, for the circumstances are in several respects entirely different, and the time which must be taken from other trades for carrying on the fisheries is not so long as not to leave some time over for these other trades. The inconveniences, as far as Bohuslän is concerned, will probably be great enough to call the attention of the persons concerned thereto. In Scotland the herring fisheries are carried on by the aid of hired men from the interior of the country, who are away from home as long as the fisheries last, but I have been unable to find anything to show that agriculture in Scotland has suffered thereby.

National character has an important influence on the development of the fishing trade. There is a vast difference between the national character as developed in the Netherlands and its flat coasts and on the rocky coasts of Norway and Bohuslän. It would be very hard to

compel a Norwegian or a Swede from the coast of Bohuslän to do the kind of work a Dutchman will do. The national character, therefore, plays a much greater part in the question as to the proper manner of carrying on the fisheries than people hitherto have been inclined to believe. If, for instance, there is the least approach to sport in the manner of carrying on the fisheries, this trade is eagerly sought by the fishermen of such nations whose national character is inclined that way. This was even the case with us at the time when the mackerel-fisheries were principally carried on with hook and line. In America new methods of carrying on the fisheries, suited to a lively national character, have sprung up. One of these methods is to equip a vessel which seeks the schools of fish in the open sea, and with an ingenious apparatus makes a rich haul in a very short time. The difficulty lies in the searching for the schools, and it is therefore an object to get fast-sailing vessels and experienced seamen. While this method of fishing, on account of the change from the search and the fast sailing to the fishing itself, is not near so tiresome as the Dutch so-called "great" fisheries, with their slow manner of fishing with seines; it also pays better and gives the fishermen greater liberty. The greater perfection of the apparatus permits them to make in a comparatively short time the same hauls as the sleepy Dutch way of fishing makes in a week or longer. Even the Scotch method of catching herring must be considered as sport compared with the Dutch fisheries.

It is generally known that our great Bohuslän herring-fisheries, as well as the Norwegian spring-herring fisheries, are secularly periodical, that is, they last at most about half a century, and after that the herring stay away fifty, sixty, or seventy years. The exact time cannot be determined. The various herring periods, both of their presence on and their absence from the coast, will, however, average fifty-six years. Even in the western part of the North Sea, near Scotland, the herring-fisheries are secularly periodical, but not to such an extent as in the eastern part of the North Sea. The circumstance that on the east coast of Scotland the fisheries can be carried on every year, the localities or so-called fishing grounds changing from time to time, has a very considerable influence on the manner of carrying on the fisheries. It is evident that permanent fisheries will favor the development of trades which require that the population should be educated to greater skill in them through a long series of years. But when secular periodical fisheries commence, the object is, of course, to obtain the best possible result with as little exertion as possible in the way of learning how to carry on the fisheries. People are generally found to be but little acquainted with the fisheries. It is generally the rural population which clubs together and gets the material which it deems the most profitable; and with this material they carry on the fisheries as best they can. The fact is that these persons who all of a sudden and without any previous experience engage in the fisheries have nothing

else in view but to make money. As a general rule, they do not have much capital to invest; they therefore want cheap apparatus, and, although in many cases good seamen, they are not particularly inclined to go farther out to sea than is absolutely necessary to attain the object in view. This applies particularly when the fisheries are to be carried on during the dark and stormy season of the year. All this, of course, exercises a considerable influence on the fishing trade, which cannot be changed all of a sudden. If, for instance, in Bohuslän an attempt was to be made to introduce another method of carrying on the fisheries than the one determined by the above-mentioned circumstances, this would take so long a time that the fishery period would come to a close before the change had become generally introduced.

Several decades are but a short period in the matter of producing highly developed forms of trade, and of educating the population to engage in an occupation which requires long practice and experience. It must also be taken for granted if, as is the case at the present time in Bohuslän, the fishing population does not move between the various great fisheries, following the herring in their migrations along the coast, that there is no way of remedying the evil. At the time when Bohuslän, as well as Norway, belonged to Denmark, matters were very different in this respect, and when the fishing period commenced both experienced Danes and Norwegians visited the coast of Bohuslän. In a short time, therefore, we had a fishing population which carried on the fisheries with apparatus which it was accustomed to handle, as nets could also be employed. This cannot be done now, but we must build on whatever foundation we possess. It also became evident in the seventeenth century that when the same kind of nets were used as during the Norwegian time in the sixteenth century, this proved a great hindrance in the way of the development of the fisheries, as it was impossible with such a method to obtain at once great results. It is evident that permanent fisheries cause the fishing population to engage in the same as in their proper occupation, and that thereby they obtain a degree of skill and experience which makes the fisheries more productive and makes them a source of income to a much larger number of persons. But, on the other hand, it is evident that the secular periodical fisheries must confine themselves to such methods as will insure good results with a less numerous and less skilled fishing population. Such methods cause much less trouble at the end of a fishing period, while the number of people left without a regular source of income at the end of a period is much smaller.

It is well known that the great herring-fisheries have played a more important part in former times than they do now. All of us have doubtless heard of the great Skania and Dutch fisheries. It is an old adage in Holland that Amsterdam is built on herring bones, and that it owes to the herring-fisheries its origin and development. The Emperor Charles V is said to have declared that the herring-fisheries

brought greater wealth to the Netherlands than the treasures of America to Spain. It will therefore be interesting to see how this trade first sprung up. In olden times the Dutch fishermen visited foreign coasts and there carried on coast fisheries. Thus, they visited Skania during the twelfth and thirteenth centuries, and Bohuslän during the fourteenth century. They did not, however, devote themselves exclusively to the fisheries, but also to commerce. They brought goods and exchanged them for others, which, on their return, they scattered all over the continent of Europe. This business paid very well, and the result was that the Dutch for some time controlled the greater portion of the commerce of the Baltic and of Scandinavia. Commerce was for a considerable period their principal object in engaging in these fisheries. Later the Dutch carried on fisheries on the coasts of Scotland and Norway, and there the method of fishing was gradually developed which at the present time characterizes the "great" Dutch fisheries. Towards the end of the fourteenth century Willem Beuckelszoon, of Flanders, invented an improved method of salting and packing herring. By using this method the herring could be sent to a greater distance, as they kept much longer.

In the year 1416 large seines were introduced. Formerly only small nets had been used, and near the coast probably mostly stationary nets. From that time the herring-fisheries were carried on more for the sake of the fisheries themselves than for the sake of the commerce created thereby; the fishing trade consequently lost some of its economic importance, but was turned more into fisheries exclusively. The fishing fleets gradually increased to 2,000 vessels, and as each vessel had a crew of 14 men, 28,000 persons were engaged in this trade. It will therefore be seen that it was a very extensive and important trade. From the seventeenth century, however, the fisheries began to decline somewhat, as other nations, especially the English, began to compete with the Dutch in this field. England placed every possible hindrance in the way of the Dutch fishermen, and endeavored to prevent them from fishing near Great Britain. Moreover, the Dutch capitalists and fishermen found it more to their advantage to devote their attention to other fisheries and trades, such as the whale fisheries, and in consequence the herring-fisheries began to decline. During the eighteenth century they decreased to such an extent that they had to be kept alive by artificial means, such as premiums; and this condition of affairs continued during the first half of the nineteenth century; but during the last decades the herring-fisheries have again begun to flourish and have made rapid progress. This improved condition is owing partly to the building of railroads, which greatly facilitate the sale of fish, and partly to other favorable circumstances. The Dutch can now sell large quantities of their herring in Belgium to much greater advantage than formerly. Belgium has during the last few years made great progress in every respect, and consumes a large quantity, especially of smoked

Dutch herring. New methods have also been invented of smoking herring, so as to impart to them a finer flavor, and the smoking can be adapted to the demand of the consumers, thus enabling the herring dealers to get a better price for their goods. People have also begun to use cotton thread for manufacturing nets, and in consequence smaller and lighter vessels can be used, which will carry the same number of or even more nets of the same size as the old and heavy hemp nets.

The well-known Skania-German herring-fisheries, which were so important during the Middle Ages, originated in the same way as the Dutch herring-fisheries, although the Germans aimed more exclusively at controlling the trade. It is well known that in those days large numbers of German merchants visited Skanor and Falsterbo, where many people were wont to congregate, and where a good deal of business was done outside of the herring-fisheries. These were probably the portions of our trade which the Germans desired to control more particularly; and the name "herring fair" was therefore given to the great market which was held in Skanor and Falsterbo. The needs of a laborer in those days were not great, and a comparatively large number of people could make a living even by small fisheries. People in those days lived in such a miserable way that our fishermen would be horrified if they were compelled to live in such a manner.

It is well known that there are several different ways of carrying on the herring-fisheries as to their economic value. These methods of fishing are either adapted to the prevailing economic condition or to the natural conditions of the locality where the fisheries are carried on. It is evident that if the greatest possible advantage is to be derived from the fish visiting the coast, many different methods of fishing should be employed, so as to insure the best results under all circumstances.

The apparatus, as a general rule, employed in the herring-fisheries are nets and seines. With the nets the fish are caught by rushing against the net and sticking in its meshes, while in the seine fisheries a school of fish is surrounded and the fish are drawn on shore alive, or the seine is, especially in the open sea, stretched underneath the school, so the fish are, so to speak, caught in a large bag. If we view these methods of fishing from an economic point of view, we will soon find that the greater the number of different ways in which an apparatus can be employed the better it will be. Thus, it is better if with one and the same kind of net both mackerel and herring can be caught than if only one kind of fish can be caught with it. It is also an advantage if one and the same net will catch fish of different size, and if it can be used in many different waters, so that it is possible to use it near the coast and at some distance from it. It is also evident that the apparatus which can be used in different depths is better than that which can only be used in one certain depth. It must, therefore, be considered a step forward in the fishing trade when nets were constructed in such a manner that they could be let down to a considerable depth, instead

of merely floating near the surface, as was the case formerly. It was another great step forward when a method of setting nets was discovered in Norway whereby herring could be caught at any depth. It is also true, if a fishery must be carried on with nets, that it is better to have several ways of using the nets than merely one, and to use the nets both floating and stationary, as the migrations of the fish require. The same applies to seine fishing. It was thus a great step forward, in an economic sense, when a seine was invented which could be set at any required depth.

Formerly it was customary for the seine to follow the bottom or else the surface. It was another great step forward when the Americans invented a seine which could also be used in the open sea. It is also evident that the longer the period during which an apparatus can be used, the better it will be. The longer a fisherman can use his apparatus and hope to catch enough fish to make it pay, the greater will be the chance for him to pay the interest of the capital and the capital invested in the apparatus. It is, in this respect, of special importance that, if there are fish which visit the coast at different times, the same material can be used to the greatest possible extent all the time. This is the case with the herring-fisheries on the coasts of Great Britain, and also in the Sound, where there are fisheries during the greater portion of the year, although the principal herring-fisheries take place in autumn. It is also evident that the safer an apparatus, the better it will be. Even if a fisherman is ever so courageous, he will always consider it a special advantage if he need not risk the loss of his apparatus. The fear of losing their apparatus is always great among the fishermen, especially when a considerable capital has been invested in them. This shows itself particularly in Scotland when the fishermen go out to sea. As soon as it looks as if a storm was approaching they immediately make for home, and do not venture to expose their apparatus to the dangers of the open sea. Even the danger of losing their lives plays a more important part, both as regards the fisheries and the method employed, than is generally believed. It is also clear that the richer the catch, when compared with the amount of capital invested in the apparatus, the better it will be. In this respect there is considerable difference between different localities. Much depends on the place where the fish are sold, for their value varies greatly in different places.

With regard to the floating-net fisheries near Scotland, during the last ten or twenty years the peculiarity has shown itself that the quantity of nets was increased without a corresponding increase in the average quantity of fish caught by each boat. This caused a Mr. Cleghorn, in 1864, to make a calculation when the Scotch fisheries would come to an end. He prepared a diagram showing the gradual decrease of the number of fish caught, and thereon based his calculation of the time the fisheries would probably last. He arrived at the result that the time was not far distant when these fisheries would no longer yield an in-

come. There is no reason, however, to suppose that such an event will take place, although the undeniable fact that at present a quantity of nets five or six times larger than in former times has to be used proves that the herring are more scattered than formerly. With the increase in the quantity of the nets, the expenses for apparatus have, of course, increased, while the number of trips has been diminished.

It is the general opinion that the fisheries are a trade whose economic value is constantly on the increase. In the same degree as the apparatus is enlarged it costs more money, and the fishermen are therefore compelled in some way or other to get a larger income in order to get the apparatus, which is constantly becoming more expensive. As the average yield of the fisheries per vessel has, on the whole, not increased in the same degree, it has become necessary for the fisherman to provide for the needed increase of his income in some other way. There is no difficulty about this in Scotland, as all the products of the fisheries find a ready market through the numerous railroads. For the Bohuslän people, however, such an increase in the cost of apparatus, without a corresponding increase in the yield of the fisheries, would prove a more serious matter. The great quantity of nets, however, exercises a very considerable influence on the manner in which the fisheries are carried on. People are much more afraid of stormy weather, in spite of the more general use of the barometer, and fishing trips are often made in vain, while at the same time it becomes necessary to make a larger catch on every trip when nets are used, for which reason they also must be larger than formerly. The same remarkable increase has been noticed in the Dutch and French herring-fisheries. Here, too, the number of nets has been increased, so that it is no uncommon thing for a fishing vessel to have several hundred nets. As the hauling in of the nets takes more time, the fishermen have less time to take proper care of their fish, and the very exhaustive work of hauling in the net even causes spitting of blood. Steam is therefore, to a constantly increasing extent, employed in doing this work; but this, of course, causes another increase of expenses and makes it more difficult for small capitalists to take part in the fishing trade by equipping fishing vessels, for experience has shown that joint-stock companies are but rarely calculated to insure a paying income from the "great" fisheries.

As regards the preparation of the fish, it may be said that the fisheries with floating nets in general are more profitable, as thereby the catches are more even though smaller, while with the seine fisheries the catches are often so enormous that it becomes almost impossible to prepare the fish properly. It happens sometimes in the net fisheries, when the herring approach the coast, that a rich haul is made, especially when the herring come very near the coast. This is the reason why the vessels from the southern part of Scotland generally make greater hauls than those from the northern part, owing to the fact that the herring

now prefer the southern portion of the east coast of Scotland, while formerly the case was reversed.

The circumstance that seine fisheries can quickly develop into a trade of very considerable importance, while the net fisheries need a much longer time, is explained by the fact that it requires less capital to start seine fisheries, and that these fisheries are particularly productive. We have thus had instances during a winter that the Bohuslän seine fishers, with apparatus valued at from 2,500 to 3,000 crowns [$670 to $804], could, during a comparatively short period, earn from 10,000 to 20,000 crowns [$2,680 to $5,360]. It is but natural that the news of such rich profits, which spreads rapidly, should attract people to the fisheries.

If one wishes to judge of the prospects of a fishery he must, of course, take into consideration the quantity of fish which may be counted on in proportion to the equipment, apparatus, and labor, and the average price which may be obtained for the fish. If he desires to calculate this average price, regard should be had principally to the wholesale selling of fish. If, as in Scotland and Bohuslän, the fish must be sold in a salted condition, the price should be taken which salt fish bring in the great ports of the Continent, especially in Stettin and Hamburg, taking, of course, into account the expenses under the heads of customs, freight, insurance, &c., and subtracting the sum from the price paid for the fish. A further reduction will be caused by the necessary expenses for salt, barrels, labor, and the profit always allowed to the persons engaged in the preparation of the fish. No account should be taken of the exceptional prices paid for small quantities of fresh fish which are imported into the ports of sale at times when the supply is small compared with the demand. These exceptional prices are often so high as to exceed by far the prices paid for salt herring. It thus happens, as in Bohuslän, that when the seine fisheries commence in autumn, the demand from German smoke-houses is very great, and that as much as from 25 to 30 crowns [$6.70 to $8.04] is paid per barrel of common Bohuslän herring. It is impossible for the Bohuslän salters to pay such prices, and the highest price they can afford is 12 crowns [$3.21] per barrel. As a general rule, it does not pay to engage in regular fisheries of rare and expensive kinds of fish. Near Yarmouth, however, a kind of herring is caught which comes near to the land, and is therefore called "longshore herring"; of these herring, however, not more than 2,000 barrels are caught per annum. That quantity is considered very good, and it is no uncommon occurrence that the fishermen will get as much as 6 pence apiece for fresh herring of this kind. They are smoked lightly, and are then generally sent to London by express train, where as much as 1 shilling apiece is paid for them. We would, of course, arrive at erroneous results if we were to calculate the entire yield of the great Yarmouth herring-fisheries according to the prices which are paid by the piece for such a rare delicacy. We should also take into consideration the time during which the apparatus can be

otherwise employed, when the vessels can be used for other fisheries, so that an extra income is derived which may aid to pay the interest on the capital invested, and eventually the capital itself.

At all times the question has frequently been discussed whether the herring-fisheries can be furthered by any measures taken by the Government, and as the Dutch fisheries enjoyed the greatest reputation, these measures generally aimed at creating fisheries like the great Dutch herring-fisheries. In Sweden, Axel Oxenstierna endeavored to create large fisheries on the Dutch model. For a long time he carried on negotiations with England for a treaty by which Swedish subjects should be permitted to fish in English waters, and Cromwell finally consented to let 1,000 Swedish vessels fish on the English and Dutch coasts. Gottenburg was granted special privileges as regards the herring-fisheries on the Dutch model. The great herring-fisheries which were aimed at, however, never developed properly. During the eighteenth century a Stockholm firm, A. & J. Arfwedson & Co., was granted the privilege of carrying on herring and cod fisheries in the Dutch manner, and they carried on these fisheries for several years. Vessels were fitted out which every year were engaged in the herring-fisheries, during midsummer near the Shetland Islands, and later in the season near the coast of Bohuslän. But these fisheries gradually gave way to the Bohuslän coast fisheries. This was possibly caused by the circumstance that the herring which during the interval between the herring periods visited the coast of Bohuslän were of an excellent quality. Although they could not in every respect be compared with those caught near the Shetland Islands, they nevertheless were so much like these that the difference in quality was not sufficiently great to justify people in paying the higher price demanded for the Shetland herring. In consequence the coast fisheries injured the Bohuslän high-sea herring-fisheries during the greater portion of the last Bohuslän herring period.

Similar attempts were made in Denmark and Norway without much result. In France the Government, after the loss of her American colonies, made efforts to introduce herring-fisheries on the Dutch model; and by making enormous sacrifices France has succeeded in creating very considerable herring-fisheries in the North Sea and in the Channel. In Germany efforts have also been made to further the development of such fisheries, and by engaging some Dutch fishermen the Germans have succeeded in catching about 5,200 barrels of herring in 1881, and 7,200 barrels in 1882—in truth, a very trifling quantity. In Scotland vigorous efforts were made during the seventeenth and eighteenth centuries to introduce herring-fisheries on the Dutch plan. During the eighteenth century hundreds of thousands of pounds sterling were paid as premiums to persons fitting out vessels and preparing fish on the Dutch plan, but without the desired result, except to show what an incentive premiums are. The whole system has been well characterized by Adam Smith, in his famous work on the "Wealth of Nations," when

he says that "people engaged in fisheries to catch premiums, and not fish." Later, in the year 1824, Dr. I. MacCulloch, in an excellent treatise on the Scotch herring-fisheries, expressed the wish that the time might never come when it would become necessary in Scotland to have recourse to Dutch fishing methods, and to have high-sea herring-fisheries. People began to see clearly that both from an economic and social point of view these fisheries were much less profitable than the Scotch coast fisheries, which were developed on a national basis. A curious illustration of the fact that these Dutch fisheries were but little worthy of imitation was furnished by the Dutch delegates to the conferences which were held between the Scotch and Dutch about the middle of the sixteenth century, these delegates maintaining that the Scotch could not well carry on such fisheries. They informed the Scotch that these fisheries were so poor that they would never desire to engage in them. This proved true, and in spite of all attempts in this direction, aided by liberal premiums, the Dutch method has not been introduced in Scotland.

When the British Government, in the beginning of the present century, determined to lend more powerful aid to the Scotch herring-fisheries, and to pay premiums for improved methods of preparing herring, these fisheries began to flourish to an extraordinary degree; and the same may be said of the other sea fisheries. The sums appropriated were certainly large, but the results have been astonishing. The care which the Government took to obtain a good market for the Scotch herring developed a trade which, in every respect, is the healthiest fishing trade on record.

In 1881 there were engaged in the herring-fisheries 4,997 vessels, with an average of 30 feet of keel and a total capacity of 79,496 tons; 4,423 vessels, with a length of keel varying from 18 to 30 feet and a capacity of 21,943 tons; and 5,389 vessels, with an average length of keel of about 18 feet and a capacity of 12,720 tons, making a total fishing fleet of 14,809 vessels, with a tonnage of 114,159 and a total crew of 48,121. The Scotch sea fisheries, in addition, give employment to 1,063 salters, 2,398 coopers, and 45,291 other persons, making a total of 96,873 persons. The value of the fishing vessels is £622,452; that of the nets, £663,572; of the other apparatus and material, £112,437; in all, £1,398,461 [about $6,782,500]. As appears already from these figures, the herring-fisheries are by far the most important fisheries, and by the manner in which they are conducted they give to the Scotch sea fisheries their true character, viz, that of coast-fisheries. The Scotch coast herring-fisheries are at the present time the most extensive herring-fisheries known as to the pecuniary value of the fish caught. A great deal may be learned from the Scotch in this respect. The experience of the Scotch shows that one may be mistaken in making up one's mind beforehand that a certain method of fishing is the right one,

and that the development of the true method may be hindered and made difficult by working to introduce the method which erroneously is supposed to be the best, but that by aiding the sale of fish a trade may be furthered which is not much thought of, and assume dimensions of which no one dreamed. It is evident that if efforts are made to extend the market for fish, which may be done in many different ways, as by taking measures to have a first-class article prepared, and by granting certain privileges to the export trade, the fishermen, who thereby obtain a better price for their goods, find the means to acquire better material and apparatus, and adopt methods of carrying on their trade which became possible only because of the higher prices paid for fish. It is clear that as a general rule it will be impossible to force a trade into existence unless the necessary economic conditions are given. Otherwise the result will be the same as that of the Scotch fisheries after the Dutch manner, artificially fostered by premiums, viz, that the fisheries continue just as long as these premiums are paid, and no longer. It is, moreover, self-evident that if it is impossible to obtain the very best of anything, one should content himself with what he has, and try to make the best of it. Never forget the old legend of Atte, who, after he had got a whole sleigh full of game, chased a squirrel so long that he lost both the sleigh and its contents.

A method of furthering the sale of herring, which from an economic point of view must be considered remarkable, is the so-called "testing of the herring." During the Middle Ages special men were appointed who tested herring and other articles of food. In the north of Germany these men were called *bracker*. They had to testify whether the goods were of the desired quality, and if this was not the case the goods received a certain stamp to show their inferior quality. Later this testing developed into a classifying of the goods, according to their different quality, by different stamps. If such a method of testing is to prove an advantage to the herring-fisheries, it is necessary that it should be done in the country from which the fish are exported, and that it is done in such a manner as to inspire confidence. For this reason the Government of Scotland, in 1809, appointed testers who watched the preparation of the herring during the entire salting season, and after the prepared fish had been examined the barrels were marked with the prescribed crown stamp. This was continued till the year 1859. Already previous to this time some opposition to the testing of fish had made itself felt in Scotland, and the result was that it was resolved that those persons who desired to have their fish tested had to pay a certain fee for it. In spite of the fact that this fee has now to be paid for every barrel of herring which is tested, the number of barrels which are tested and stamped has increased very considerably. During the period 1860–'69 the manufacture of salt herring increased 29.6 per cent., while the number of barrels tested and stamped during the same period increased

55 per cent. It has been objected to the testing in Scotland that it was not in conformity with the ideas of modern times, and that it benefited only those salters who were not able properly to superintend the salting, and had therefore to have other persons to do it for them. It is evident that if the tester refuses to impress the crown stamp on a considerable quantity of herring, this shows that the salting has not been properly superintended. Those persons, therefore, who do not personally superintend the salting of their fish derive great benefit from the testing. This testing, moreover, is considered with great favor in the German market. In Germany the testing and stamping is frequently considered such an absolutely sure indication of the good quality of the herring that they are sold from one person to the other without being examined. This is a great advantage, for if the barrels are to be opened merely to examine the quality of the herring, these will often suffer thereby. The testing is also an advantage for the salters. They find it easier to obtain a loan of money if they can show that they export crown-stamped herring. It must also be taken into consideration that the tested and stamped herring fetch a somewhat higher price in the market, and that it is much easier for new beginners in the salting business to get up in the world if they have their herring tested and stamped, for otherwise the large firms would almost make a monopoly of the exportation of herring.

The objections which are raised against the testing of herring are generally these, that it is a violation of the fundamental principles of free trade, and also that thereby the introduction of still more improved methods of preparing herring is prevented. The last-mentioned objection would, to some extent, be true, if the enormous masses of herring which are brought on shore did not make it impossible to have more than one good method of preparing the herring; for all that is required is that the large quantity of herring yielded by rich herring-fisheries shall be prepared so as to present a fine article and find a ready and extensive sale. As I have, in a recent work on the salting and testing of herring, and the herring trade in general, discussed more fully the question of testing, and its advantages and disadvantages, I shall not dwell any longer on this subject.

A method of furthering the fish trade which has been employed of late years, and which has acted somewhat against the method of testing, especially when we take into consideration the possibility for new beginners to work their way, is the holding of fishery exhibitions. It is clear that the prizes which are given at such exhibitions prove of some, though, perhaps, not very great, advantage to those who receive them (those who do not receive any prizes suffering a corresponding disadvantage), without furnishing a guarantee that the articles which have received a prize will be good when brought into the market; for even if the article in after times deteriorates, it will retain under all circum-

stances the distinction gained by the prize. Very frequently the articles placed on exhibition are not at all intended for the market, but are specially prepared for an exposition. Many other objections might be raised against these exhibitions, which, as it seems, are repeated too frequently, and which, though well meant, are of no great practical value.

The herring-fisheries have also been encouraged by putting a heavy import duty on herring, a measure which, of course, can only be advantangeously employed in very populous herring-consuming countries, like France and Germany.

XI.—THE NORWEGIAN FISHERIES IN 1883, WITH STATISTICS OF PREVIOUS YEARS.*

The cod fisheries near Spitzbergen proved a complete failure. The Tromsoe Fishery Association reports as follows: "This fishery seems to be still more unreliable than the capelan fisheries. Many fishermen believe that we have entered a period, which possibly may last several years, when the cod will stay away entirely from Spitzbergen." Tromsoe equipped 10 vessels for the cod fisheries. The other vessels engaged in these fisheries came from the following places: 1 from Trondhjem, 2 from Christiansund, 2 from Aalesund, 1 from Arendal, and 2 from Hammerfest.

THE BANK FISHERIES NEAR AALESUND—(Communicated by Consul M. Hansen).—In the winter fisheries there were engaged 90 Norwegian vessels, with a total crew of 747 men, and the number of fish caught by these vessels was 465,200. Of Swedish vessels there were 25, with a total crew of 250 men; the number of fish caught by these was 161,200.

In the summer fisheries at Storeggen there were engaged 22 vessels, 21 Norwegian and 1 Swedish, with a total crew of 270 men. The following quantity of fish was caught by these vessels: 1,272,000 kilograms ling, 157,000 kilograms torsk, 814 hectoliters liver, and 246 hectoliters roe, the total yield representing a value of 155,548 crowns [about $41,686.86]. The yield of klip-fish of both fisheries would therefore be about 1,100,000 kilograms.

The winter cod fisheries in the Stavanger district are said to have yielded about 200,000 cod.

The Havbro cod fisheries (fisheries on the banks in the Polar Sea) were carried on by a vessel from Tromsoe, as an experiment by the fishery association of that town. The yield amounted only to 3,500 cod. This small quantity, it is said, was principally owing to the lack of fresh bait.

THE ICELAND COD FISHERIES.—From information received by the editor of this journal it appears that 23 vessels from various Norwegian ports were engaged in these fisheries. The total yield was 200,000 cod, the greater portion of which was sold in England. The largest

* "*Norske Fiskerier*, 1883." From *Norsk Fiskeritidende*, Vol. III. Bergen, January, 1884. Translated from the Danish by HERMAN JACOBSON.

catch amounted to 34,000. Seven vessels from Aalesund were engaged in these fisheries, with a total crew of 56 men, their tonnage varying from 21 to 103. The individual shares of the crews varied from 135 to 400 crowns [$36.18 to $107.20]. Besides cod there were caught haddock, halibut, wolf-fish, sea-perch, torsk, codfish (some unusually large), and ray. Some fishermen had taken herring nets along and caught a sufficient number of herring for bait and for their own food. From the information received it appears that it took about 1,200 cod for a ton of liver. The fishing season lasted from the middle of June till the beginning of September. Both on the east and west coasts of Iceland the fisheries were occasionally hindered by the ice.

THE FINMARK WHALE FISHERIES.—In East Finmark the following Norwegian vessels were engaged in these fisheries: From Tonsberg, 8 vessels, with 221 men; from Sandefiord, 5 vessels, with 144 men; Laurvig, 1 vessel, with 30 men; Arendal, 1 vessel; Bergen, 1 vessel, with 28 men; Trondhjem, 1 vessel, with 28 men; and Christiania, 3 vessels, with 75 men. The engines on these vessels were generally 30 horse-power, some 15, and a few 40. The above 20 vessels were stationed as follows: 2 in Vadsoe, where there is a guano factory, 3 in Jarfiord, 1 in Pasvig, 1 in Madvig, 2 in Kobholmfiord, 1 in Kiberg, 3 in Svartnæs, 1 in Smelroren, 2 in Syltefiord, 2 in Engelviken, 1 in Stegelnæs, and 1 in Vardoe.

The following was the result of the fisheries: At Vadsoe, 24 whales, or 12 per vessel; in the South Varanger district (Jarfiord, Pasvig, Madvig, and Kobholmfiord), 124 whales, or 18 per vessel; in the Vardoe district (Kiberg, Svartnæs, Smelroren, and Syltefiord), 178 whales, or 26 per vessel; and at the island of Vardoe (Engelviken, Stegenæs, and Vardoe), 72 whales, or 18 per vessel; making a total of 407 whales, or 20 per vessel. Most of the whales are caught 7 or 8 Norwegian miles (about 4.7 English miles each) from the coast. The fisheries commenced in the beginning of April and came to a close about the middle of August. One Russian vessel was engaged in these fisheries, and was stationed in the Mokkafiord. It caught 22 whales. Next year 2 more Russian vessels will be engaged in the whale fisheries.

In West Finmark 3 vessels were engaged in the whale fisheries, all from Tonsberg; 2 of these were stationed at Sorvær and 1 in the Tu fiord. The total catch was 99 whales.

The average value of the train-oil is 500 crowns [$134] per ton, or $13.40 per keg of 102 kilograms net, from which should be subtracted for freight 3 or 4 crowns [80 cents to $1.07].

The Finmark whale fisheries owe their origin to M. Svend Foyn, of Tonsberg, who in 1864 made the first attempts near Vardoe and in the Warangerfiord, and continued them in 1865, 1866, and 1867. In 1866 he caught nothing, and in 1867 only one whale, while in 1868 he caught 30. In the following year he sent out 2 vessels, which, however, caught only

17 whales. Later the yield of these fisheries, not counting those whales which were cast ashore, has been as follows:

	Whales.
1870	36
1871	20
1872	40
1873	36
1874	51
1875	37
1876	42
1877	32
1878	130
1879	123
1880	145
1881	279
1882	386
1883	506
In all, since 1866	1,911

In 1877 a new association was formed at Jarfiord, and in 1881 one new establishment was founded in East Finmark, at Vardoe, and two in West Finmark, 2 at Tufiord, and 1 at Sorvær. In 1882 the whale fisheries were carried on by 8 associations, with 12 vessels, which number in 1883 rose to 14 associations, with 23 vessels. There are at present 11 establishments in East Finmark and 3 in West Finmark.

THE SEAL FISHERIES IN THE POLAR SEA.—This fishery yielded 121,072 skins, 48 bottle-noses, 25 bears, 22,140 tons of fat, and 1,800 tons of train-oil, the total value being estimated at 1,900,000 crowns [$509,200], while the expenses of fitting out were 30,000 crowns [$8,040] per vessel. The total number of vessels engaged in these fisheries was 16, all of them steamers.

The first Norwegian who engaged in these fisheries, which for a long time had been in the hands of the English, was Svend Foyn, of Tonsberg, who in 1847 fitted out a vessel for the seal fisheries. Till 1852 he sent out only this one vessel, but in that year he sent out 3 vessels; in 1853, 5 (among these 1 from Christiansand); in 1854, 9; and in 1855, 13 (among these one from Sandefiord). During the next five years these fisheries developed gradually, and several others towns sent out vessels. In 1860, 21 Norwegian vessels were engaged in the seal fisheries, viz., 1 from Frederikshald, 1 from Frederikstad, 2 from Drammen (from 1859), 13 from Tonsberg, 1 from Sandefiord, 2 from Laurvig (1857), and 1 from Christiansand. From 1856 to 1858 Holmestrand sent 1 vessel. During the ten years 1861 to 1870 the number of vessels annually engaged in the seal fisheries varied from 15 to 18. In 1866 steamers were employed for the first time, viz., 2 from Tonsberg. It was some time, however, before steamers were more generally employed, for in 1871

their number was only 3. After that year, however, their number increased more rapidly; in 1872 their number was 9 and the number of sailing vessels 14; in 1882 the last sailing vessel was fitted out for these fisheries.

THE SHARK FISHERIES AND THE SPITZBERGEN FISHERIES.—The total number of vessels sent out from Tromsoe was 40, with an average crew of 8 men and an average tonnage of 44. Of these vessels 1 belonged to Christiania, 1 to Arendal, 2 to Stavanger, 1 to Bergen, 1 to Trondhjem, 1 to Helgeland, and 34 to Tromsoe. Four of these vessels did not catch anything. The vessels from Christiania and Arendal took home with them all they caught. The yield of the 34 vessels which brought their catch to Tromsoe was the following:

	Crowns.
211 walrus, at 130 crowns	27,430
5,426 seal, at 16 crowns	86,816
226 whitefish, at 100 crowns	22,600
80 polar bears, at 60 crowns	4,800
265 reindeer, at 10 crowns	2,650
907 kilograms eider-down, at 2.25 crowns	2,041
1,015 hectoliters shark liver, at 21.50 crowns	21,822
Total	168,159

Of the 40 vessels 23 were stationed near Spitzbergen, 6 near Nova Zembla and in the White Sea, and 11 near Havbroen. Besides these vessels, 2 from Sandefiord and 2 from Aalesund were engaged in the Spitzbergen fisheries, and caught 166 whiting, 190 seals, 3 walrus, 2 polar bears, and besides secured a small quantity of eider-down.

Regarding this year's fisheries (1883), the Tromsoe Fishery Association reports as follows: "In the Murman Sea, or near the entrance to the White Sea, where seal fisheries are going on in May and June, the fisheries were very successful. Near the Kolguev Island an unusually large number of seals were caught. Owing to the favorable condition of the ice near Spitzbergen, which allowed the fishermen to go farther north and east than usual, a larger number of walrus was caught than during any previous year. The violent persecutions to which these animals have been exposed for many years have driven them farther north and east, where they can be caught only in years when there is not too much ice.* The shark fisheries which were carried on along the Tromsoe coast were less successful than usual, while a good many of these fish were caught in the Waranger fiord and near Spitzbergen."

The fisheries near Spitzbergen, principally for walrus, seals, and polar bears, which in former times had been in the hands of the Dutch and later in those of the Russians, were not shared by the Norwegians till the year 1820. Till 1860 Hammerfest was the principal Norwegian port

*The average annual number of walrus caught from 1830 to 1834 was 1,807; in 1876 the number caught was 1,286; in 1878, 621; in 1881, 444; and in 1882, 148.

which equipped vessels for these fisheries, sending out 10 to 15 a year. Later some other Norwegian towns followed the example of Hammerfest, especially Tromsoe. The number of Norwegian vessels engaged in these fisheries during the period from 1866 to 1877 was 45, viz.: 1 from Vardoe, 22 from Hammerfest, and 22 from Tromsoe. During this period the first attempt at fisheries was made near Nova Zembla (in 1867).

Regarding the fisheries in the Polar Sea the following data have been furnished by the Tromsoe Fishery Association:

Fisheries.	Time of sailing.	Time of return.
Seal fisheries in the White Sea	Middle of April	In the most fortunate case in the beginning of June, but generally in the beginning of August.
Walrus and seal fisheries near Spitzbergen and Nova Zembla.	1st of May	In September, sometimes not till October.
Whiting fisheries	15th of May	Beginning of September.
Spitzbergen cod fisheries	Middle of June	Beginning of September.
Shark fisheries	1st of April	End of September.

During that time 3 or 4 trips are made.

The following data have been furnished relative to the expense of fitting out the vessels and the income from these fisheries:

The outfit of a vessel for the walrus and seal fisheries, with a crew of 10 men, will generally cost about 3,000 crowns [$804]. To this sum should be added 700 crowns [$187.60] advanced to the crew, making a total of 3,700 crowns [$991.60]. The crew generally receives one-third of the gross yield of the fisheries, and this third part is generally subdivided into 4 more parts than there are men. If the crew, for instance, numbers 10, each man receives one-fourteenth of one-third of the entire yield, except the mate, who receives two-fourteenths. The remainder, three-fourteenths, goes to the company. The company provides the entire outfit, including food, and pays the mate 100 crowns [$26.80] per month, and each harpooner from 60 to 100 crowns [$16.08 to 26.80]. Each vessel has generally two harpooners.

The outfit of a whiting vessel costs about 1,000 crowns [$268] more, which increase is principally caused by the seine, which costs about 5,000 crowns [$1,340], and which, as a general rule, will not last longer than 5 years. The company also pays for the entire outfit, food, &c. As regards the monthly pay and the division of the yield, different rules prevail from those in the walrus and sea fisheries. Each fisherman receives from 20 to 24 crowns [$5.36 to $6.43] per month, and the mate about 100 crowns [$26.80]. If a harpooner accompanies the expedition to catch walrus and seals, he receives from 60 to 100 crowns [$16.08 to $26.80] per month. The entire yield of the fisheries (including seals and walrus) is divided into 6 parts, one of which goes to the crew and is divided on the following principle: If, for example, the crew, including the mate, is composed of 10 men, 9 receive one-twelfth of one-sixth of the yield, the mate two-twelfths, and one-twelfth goes to the company.

To equip a vessel for the cod fisheries, if some provision also is made to catch seal, &c., costs about 2,000 crowns [$536], including salt and ready money advanced to the crew. The yield is divided equally between the crew and the company. The crew pay for their food and their share (one-half) of the salt and provide their own fishing apparatus. Occasionally, however, crews stipulate for having free salt.

In the shark fisheries the equipment for the summer, including the wear and tear of the apparatus, food, and money advanced to the crew, is generally estimated at 2,000 crowns [$536]. If the company provides food, the crew receives one-third of the yield; while if the crew provide their own food, they receive one-half of the yield.

Both in the cod fisheries and the shark fisheries the mate receives 2 men's shares of the yield, and besides this generally a monthly sum from the company. In all these fisheries the company has the first chance to buy the shares of the crew, at the wholesale market prices. In giving the cost of fitting out vessels for the various fisheries, the insurance premium has not been counted in. The insurance on the Spitzbergen vessels has during the last years amounted to from 5 to 9 per cent of their value.

Whiting fisheries are said to have been carried on with seines at Spitzbergen by the Russians during the period from 1820 to 1830. The Norwegians first commenced to engage in these fisheries in 1867, with 2 vessels, which caught in all 15 fish. In 1868 eight vessels were engaged in these fisheries, and their number increased from year to year till 1872, when it seemed to have reached its greatest height. From that year these fisheries began to decline, and in 1876 only 2 vessels were engaged in them, 1 from Trondhjem and 1 from Tromsoe, the former of which, however, was engaged principally in the cod fisheries. Since then the number of vessels engaged in the whiting fisheries has again risen to 8.

Nova Zembla, owing to the territorial boundary, has much less importance as a fishing station for Norwegian vessels than Spitzbergen. The whiting fisheries near Nova Zembla are for this reason almost exclusively in the hands of the Russians, who during the last year have caught a great many fish. Since 1867 a few Norwegian vessels from Tromsoe and Hammerfest have, as a rule, annually visited Nova Zembla and engaged in the walrus and seal fisheries, and generally with favorable results.

As regards the fishing expeditions sent out from Hammerfest, we have received the following report from Messrs. Feddersen and Nissen, with the remark that, as they possess only very incomplete data, there may possibly be some errors in the figures:

Hammerfest has sent out on the seal and walrus fisheries near Nova Zembla 5 vessels, with a a total tonnage of 159 tons and about 50 men, *i. e.*, 10 or 11 for each vessel, viz., the mate, first harpooner, second harpooner, and 7 fishermen. Each vessel has 2 fishing boats with complete

fishing apparatus, and besides these 1 boat for general use. Sometimes the mate also acts as first harpooner. One man is hired to take the mate's place while he is out with the fishing boats. Each fishing boat has a crew of 4 men. While they are out 2 men remain on board, and sometimes 2 men and 1 boy. These 5 vessels have brought back from the coast of Nova Zembla (occasionally they were also engaged in the seal fisheries on the ice, as the seal about that time of the year come from the White Sea), 160 walrus, 2,678 seals of different sizes,* and 3 polar bears, valued at 51,684 crowns [$13,851.31]. Some of these vessels were very successful in the seal fisheries, but these expeditions to the coast of Nova Zembla have, as a general rule, not been very profitable, especially if—as has been the case during two successive years—they could not enter the Sea of Kara. Last year seal-skins brought a good price, so that the fisheries paid; the oil, however, was offered at too high a figure.

For the Spitzbergen fisheries Hammerfest equipped 7 vessels, with a total tonnage of 209 and a total crew of 70 men, viz., 6 vessels with a crew of 10 or 11 men, and 1 with 7 men, having only one fishing boat. These 7 vessels caught and brought home 230 walrus, 1,108 seals (mostly large), 17 polar bears, 45 reindeer, and 130 kilograms of eider-down, valued at 59,458 crowns [$16,034.74].

The fishing area is not very large. If many more vessels were to engage in these fisheries, the animals would go farther north into the icy regions, and the entire fisheries would be ruined in a few years.

At the banks in the Polar Sea, principally near the Bear Islands and the south coast of Spitzbergen, shark fisheries were carried on exclusively. Fifteen vessels were engaged in these fisheries, with a total tonnage of 415; 13 had a crew of 6 or 7 men each; and 2, only 5 men. They brought home 2,067 tons of shark-liver, with an estimated value of 51,675 crowns [$13,848.90]. Two small vessels, with a total tonnage of 35, were engaged in the cod fisheries near the coast of Spitzbergen,† but only caught a few hundred cod.

Whiting fisheries were attempted from Hammerfest, we believe, in 1869 or 1870, by John Berger and a firm in Bergen (probably Mohr & Son), who fitted out a large steamer, with an extraordinarily large and expensive seine; but the enterprise proved an entire failure. In 1872 an expedition for catching whiting was attempted with a sailing vessel, but the results were exceedingly small, and as other attempts made during the following years were equally unsuccessful, no further expeditions were sent out. The expeditions sent out from Tromsoe have been more successful in catching whiting near Spitzbergen; but experience has shown that these expeditions do not pay, as good whiting fisheries are purely accidental and very rare.

* As a general rule, 1 large seal is supposed to yield 1½ tons of fat or 1 ton of oil, and 7 to 10 small seals about 1 ton of fat.

† In all about 700 men from Norway have participated in the various fisheries in the Polar Sea beyond the limits of Norwegian waters.

THE MACKEREL FISHERIES.—(Communicated by Inspector Buch.)—The following table gives the result from those places which made a report:

Districts.	Fishermen.			Yield.				Gross share per fisherman.	Foreign buyers.
	Vessels.	Boats.	Men.	Number.	Value.	Salted and used.	Exported.		
					Crowns.			*Crowns.*	
The Jarlsberg and Laurvig districts.	116	....	445	435,000	87,000	....	....	195	(*)
Lister and Mandal districts. †	329	2	1,195	2,497,400	329,300	1,556,000	941,300	274	......
The Stavanger district. ‡	200	70	934	1,612,000	217,800	618,000	994,000	220	55
Total	717		2,574	4,544,400	634,100	....	....	246	......

* 120 boats with 2 men each. † 2 lives lost. ‡ 3 lives lost.

The average share per fisherman in these three districts was in 1882 198 crowns; and for the whole country in 1881, 200 crowns; in 1880, 187 crowns; in 1879, 202 crowns; and in 1878, 218 crowns.

The Fosen cod fisheries are reported to have yielded in all 1,000,000 cod.

SEINE FISHERIES FOR HERRING.—Besides the fisheries carried on by the regular company, some herring were caught by a vessel of 60 tons and a crew of 4 men, fitted out by Messrs. Lehmkul, of Bergen. This vessel was engaged in the fishery from 10 to 20 miles west of Espevær for three weeks, commencing about the middle of May. In the beginning 1½ to 3 tons of herring were caught per set of seines (18), and towards the end of the month once 7 and another time 8 tons. The herring were of medium size, with little fat, but full of small red crustaceans. In one of these herring, which was examined by the editor of this journal, and which measured 274 millimeters [about 11 inches] in length, the roe measured 92 millimeters [about 3⅝ inches] in length and 9 in breadth, and weighed 4 grams [about $\frac{1}{7}$ ounce.]

Mr. Jorgensen, of Hisken, at about the same time made an attempt at herring fisheries between Skudesnæs and the Sœbjorns fiord. The greatest distance from the shore at which these fisheries were carried on was 3 Norwegian miles [= 14 English miles] from Udsire. The catches varied from 100 fish to about half a ton. On account of the clear nights the fisheries came to a close in June, and were not continued later during the season. About 10 to 12 boats engaged in the herring fisheries from Smorstak out toward the Skudesnæs fiord as far as 3 to 5 miles from Hvidnigsoe, but, on the whole, it cannot be said that these fisheries were particularly successful.

During the spring herring fisheries three Dutch cutters made some attempts to catch herring, twice near Lister and twice near Haugesund. The entire yield of each vessel was 5 or 6 tons. These attempts must, therefore, be termed failures; but the cause must probably be sought

rather in the unfavorable condition of the weather and in the selection of unsuitable times and places than in lack of skill and enterprise. About 100 Norwegian boats were engaged in the herring fisheries between Udsire, Rover, and Bommelbaad. The yield varied greatly and cannot be termed very successful.

The attempt made by the Dutch will not be repeated. A Norwegian vessel caught spring herring 14 miles from Egersund as early as December 7. At Hvidnigsoe and Skudesnæs spring herring were for the first time caught on December 24.

The herring fisheries near the Hval Islands came to a close in March, and yielded an estimated quantity of 60,000 tons of salt herring, some of which, however, had been caught by Swedish fishermen. Of this quantity 24,000 tons were salted on board vessels from Haugesund, 3,000 tons on vessels from Stavanger, and 12,000 tons on vessels from Bergen.

On the Norwegian side of the Hval Islands herring were last year caught for the first time on December 14. About the middle of December large schools of herring appeared outside the Langesund fiord and the Laurvig fiord, and a large number were caught near Nevlunghavn and in the Vig fiord. At the close of the year large masses of herring were observed outside the Flekke fiord. Some specimens, which were sent to the editor of this journal, measured from 317 to 336 millimeters [14 inches] in length and were full of milt and roe, weighing from 40 to 50 grams [nearly 2 ounces].

THE ICELAND HERRING FISHERIES.—Total number of Norwegian vessels engaged, 157; seines, 383; crews, 1,807; yield, in tons, 103,886. Calculating the ton of fresh herring at 8 crowns [$2.14], and of salt herring at 19 crowns [$5.09], the total yield of these fisheries would represent the sum of 554,400 crowns [$148,579.20] and 1,973,834 crowns [$528,987.51], respectively. At the end of the year 1883, the Norwegians had in all 56 fishing stations in Iceland, each station being composed of a dwelling-house and a warehouse.

THE FAT-HERRING FISHERIES IN THE NORDLAND DISTRICT.—From January 1 till the middle of December tax was paid on 430,300 tons of herring. Some of these belong to 1882 and some were caught in the spring of 1883. These latter were estimated at 40,000 tons. On the other hand, a large quantity of herring had not yet reached the custom-houses, and many are still in the hands of Nordland merchants. The principal fisheries were carried on in October and November, and chiefly in the districts of Bejern, Skjærstad, and Bodo. From places outside the districts of Nordland and Tromsoe 50,000 tons of herring were imported into Bergen alone.

OTHER FISHERIES.—The whale fisheries near Iceland were carried on (besides by the vessels mentioned on page 267 of our last volume) by 1 vessel from Haugesund. Three companies in Haugesund also had shares in Mr. Foyn's establishment in the Isa fiord.

The shark fisheries near Iceland were carried on by 2 vessels from Haugesund and yielded 175 tons of liver. On the shore of the Isa fiord the merchants of Haugesund have established a steam oil-refinery, where last year 300 tons of oil were manufactured, mostly of the light kind, but no medicinal oil.

As to the whale fisheries near Bergen, at Skagshavn (Sartoroe) 7 whales were caught, and at Florvaag (Askoe) 2.

The coal-fish fisheries in Finmark were very successful, as during the previous year a great quantity were made into klip-fish, probably 2,000,000 kilograms. As a general rule the price of klip-fish made from coal-fish was half that of the klip-fish made from cod.

The salmon fisheries were unusually successful; but the prices were low, as there were also very rich salmon fisheries in Scotland. In Canada, likewise, the salmon fisheries were extraordinarily productive.

The lobster fisheries on the west coast were very successful.

The exports of Norwegian fishery products were as follows, at the end of November, 1883: 10,568,000 kilograms dried fish; 29,616,000 kilograms klip-fish; 6,522,000 kilograms guano; 594,500,000 hectoliters herring; 36,600,000 hectoliters roe; 106,900,000 hectoliters oil.

STATISTICS OF THE NORWEGIAN FISHERIES.

Average annual value of the principal products exported from Norway during the period 1866–1882.

Years.	Products of the forest and wood industries.	Fishery products.	Other Norwegian articles.	Foreign articles again exported from Norway.	In all.	Fishery products.
	Crowns. *	*Crowns.*	*Crowns.*	*Crowns.*	*Crowns.*	*Per cent.*
1866–'70	31, 000, 000	33, 300, 000	8, 200, 000	800, 000	73, 300, 000	45. 5
1871–'75	44, 900, 000	41, 800, 000	16, 900, 000	2, 600, 000	106, 200, 000	39. 3
1876–'80	38, 800, 000	43, 100, 000	19, 100, 000	2, 300, 000	103, 400, 000	41. 7
1881	44, 900, 000	50, 200, 000	24, 000, 000	1, 800, 000	120, 900, 000	41. 5
1882	45, 900, 000	47, 100, 000	26, 900, 000	3, 100, 000	123, 900, 000	38. 3

* The crown = 26. 8 cents. 1 million crowns = $268,000.

Exports of guano, 1883.

Custom-houses.	August.	September.	October.
	Kilograms.	*Kilograms.*	*Kilograms.*
Aalesund	185, 200	21, 300	....
Christiansund	192, 800	296, 400	85, 700
Trondhjem	171, 400	....	2, 000
Mosjoen	17, 500	....	....
Bodo	550, 700	50, 000	400, 000
Hammerfest	....	20, 000	....
Vardoe	10, 000	....	260, 000
Vadsoe	150, 000	147, 700	....
Total	1, 277, 600	535, 400	747, 700
Since January 1	*4, 700, 000	5, 200, 000	5, 900, 000

* One million kilograms = 2,204,850 pounds.

Exports of fishery products from 1815–1829.*

Periods of five years.	Klip-fish.	Dried and smoked fish.	Total.	Salt fish in tons, mostly herring.	Roe.	Train-oil.	Lobsters.
	Kilograms.	*Kilograms.*	*Kilograms.*	*Tons.*	*Tons.*	*Tons.*	
1815–'19	1, 500, 000	7, 800, 000	9, 300, 000	155, 900	8, 500	19, 200	605, 000
1820–'24	3, 000, 000	10, 300, 000	13, 300, 000	307, 700	2, 000	27, 300	927, 000
1825–'29	6, 000, 000	15, 600, 000	21, 600, 000	341, 000	22, 100	40, 500	1, 280, 000

* For the following years, see "*Norsk Fiskeritidende,*" 1883, p. 174.

Norwegian exports of fishery products in August, September, and October, 1883.

[Communicated by the Central Statistical Bureau.]

Custom-houses.	Dried fish. (1,000 kilograms.)			Klip-fish. (1,000 kilograms.)			Herring. (1,000 kilograms.)			Roe. (1,000 hectoliters.)*			Train-oil. (1,000 hectoliters.)		
	August.	September.	October.	August.	September.	October.	August.	September.	October.	August.	September.	October.	August.	September.	October.
Frederikshald	......	......	......	......	......	......	0. 1	0. 6	0. 4	...	...	...	...	...	...
Frederikstad	......	......	......	......	......	......	0. 6	1. 1	0. 1	...	...	...	...	...	...
Christiania	......	16	179	......	......	......	1. 6	5. 5	5. 6	...	...	...	0. 3	0. 5	0. 4
Tonsberg	......	......	......	......	......	......	0. 1	0. 1	...	...	...	...	5. 1	6. 0	...
Arendal	......	......	......	......	......	......	0. 4	0. 4	0. 2	...	...	...	...	...	...
Christiansand	......	......	......	2	1	......	...	......	...	...	...	...	...	...	...
Flekkefiord	......	......	......	......	......	......	0. 1	1. 8	...	...	...	...	...	...	...
Egersund	......	......	......	......	......	......	...	1. 3	...	...	...	...	...	...	...
Sandnæs	......	......	......	......	......	......	...	0. 4	0. 9	...	...	...	...	...	...
Stavanger	1	5	3	1	1	3	7. 2	23. 8	16. 3	...	...	...	...	...	0. 1
Skudesnæshavn	......	......	......	......	......	......	...	3. 1	...	...	...	...	...	...	...
Haugesund	......	......	......	......	......	......	5. 6	21. 9	10. 1	...	...	...	...	...	...
Bergen	1, 995	1, 478	1, 366	693	590	499	24. 0	42. 2	41. 1	9. 0	2. 6	0. 1	2. 6	3. 3	3. 9
Aalesund	......	......	......	565	768	237	4. 6	3. 0	3. 4	1. 8	...	...	0. 1	0. 2	0. 1
Molde	......	......	......	......	......	......	0. 7	1. 3	1. 9	...	...	...	...	...	...
Christiansund	55	10	6	2, 338	1, 714	2, 131	16. 7	20. 7	16. 2	0. 1	...	...	...	0. 4	0. 2
Trondhjem	23	26	10	......	......	......	0. 4	0. 4	0. 2	...	...	...	0. 1	0. 1	0. 1
Bodo	......	......	......	......	......	......	...	......	2. 2	...	...	...	0. 1	...	0. 6
Tromsoe	398	390	153	......	......	3	1. 0	......	...	...	...	...	0. 2	0. 6	0. 5
Hammerfest	261	361	245	......	......	......	0. 2	0. 1	...	...	...	...	0. 3	4. 5	0. 6
Vardoe	38	195	106	......	......	......	0. 6	0. 6	0. 1	...	...	...	3. 1	13. 4	17. 5
Vadsoe	94	178	631	......	......	......	0. 2	......	...	...	...	...	1. 0	3. 0	0. 5
Other places	......	......	......	......	......	......	...	0. 2	1. 0	...	...	...	0. 1	0. 2	...
Total	2, 865	2, 659	2, 699	3, 599	3, 074	2, 873	64. 1	128. 5	99. 7	10. 9	2. 6	0. 1	13. 0	32. 2	24. 5
Since January 1, 1883	†4. 6	†7. 3	†10. 0	†20. 5	†23. 6	†26. 5	278	406	506	34	36	37	42	74	98
1882	†6. 7	†10. 0	†13. 3	†24. 7	†27. 7	†32. 7	491	575	650	52	65	66	50	72	87
1881	†6. 5	†11. 0	†14. 6	†27. 7	†31. 3	†34. 3	591	735	884	44	49	52	62	81	104
1880	†8. 3	†13. 9	†16. 7	†35. 7	†40. 0	†45. 9	251	342	449	68	71	76	107	128	152
1879	†9. 9	†14. 9	†18. 1	†28. 4	†32. 7	†37. 3	382	504	636	51	53	56	94	111	127

* One hectoliter = about 22 gallons = about $2\frac{5}{8}$ bushels.

† Millions of kilograms.

XII.—THE ICELAND COD FISHERIES IN 1883.*

By C. Trolle,

First Lieutenant in the Danish Navy.

The favorable reports which reached us from Faxa Bay, stating that very successful winter-fisheries had commenced near the southern part of Iceland (*Sonderlandet*) justified the hope that the fisheries on the west coast would also prove successful, and as the Loffoden fisheries had proved an entire failure, people began to look joyfully forward to high klip-fish prices, which would, to some extent, make up for the loss occasioned by the circumstance that the commercial treaty with Spain had not been concluded.

The fishermen therefore did not allow themselves to become discouraged by a rather unfavorable beginning, as there were frequent storms during May. Whenever there was good weather for fishing, it could readily be seen that there were plenty of fish, but, strange to say, as the season advanced, as June passed, and July began, the fish appeared less and less plenty at the regular fishing-places, and this in spite of the most favorable weather. The great expectations were gradually disappointed, and people began to sigh for a little of the wind which, in the beginning of the season, had interfered with the fisheries. Everybody seemed anxious to go to new fishing-places, for the fish surely must be somewhere or other, and all that had to be done was to search for them. As soon as a little breeze sprung up people became excited, and fishing vessels fully equipped for the fisheries could every now and then be seen at the fishing-places. It was of course to be expected that many, especially new beginners, under circumstances which demand a good deal of a genuine fisherman's patience, should lose much time in a fruitless chase after fish, but then no experience was ever gained without paying it.

The cod fisheries on the western banks in 1883 must, on the whole, be considered as poor and below those of an average year. The long-line fisheries in the eastern fiords did not fare much better. As regards numbers the results were satisfactory, but the fish were so exceedingly small that the total quantity was not large, and the prices, more-

*Torske fiskeriet ved Island i 1883. From the *Nationaltidende*, Copenhagen, February 9, 1884. Translated from the Danish by Herman Jacobson.

over, were low, owing to the small size of the fish. Bait was unusually scarce. Without herring for bait the Faroe and Iceland fishermen seem to lose confidence, and all desire to row about and seek the most favorable fishing-places, but they will set their lines at random, which, of course is not generally productive of favorable results. The herring fisheries with nets were so poor during August and September, at any rate in the Reyder and Nord fiords, that people were actually surprised if twenty or thirty herring had, during the night, found their way into a net. In some cases the fishermen had to row several miles to neighboring fiords to buy fish from the Norwegians, who occasionally had caught some during the night, but it happened frequently that not a herring could be got, even for its weight in gold.

The general results were not very encouraging, and if some vessels succeeded in bringing home a considerable number of fish this only goes to prove that even in a poor fishing year the Iceland cod fisheries will repay the capital invested if they are managed systematically and economically, for it is a mistake to think that the fisheries consist in nothing but to draw the fish from the water, and expressions such as "the inexhaustible wealth of the sea" should never be understood literally.

As regards the results obtained by my vessel Alma in 1883, they cannot yet be stated accurately. The fish caught on the eastern coast are salted and laid to dry during the winter, and are not brought into the market till the following spring; but in reporting the course of our fisheries I intend to give all the data which can possibly be of interest, viz., the number and weight of the fish caught, the shrinking of the fish in salt and during the drying process, &c., from my own personal observations.

The Alma left Stavanger, Norway, on March 21, 1883, with a crew of 6 men, a supply of food sufficient for 18 men for about seven months, 250 tons of salt, a number of herring-kegs, &c., and fully equipped in every respect to take part in the Iceland fisheries. After having weathered a few severe storms from the north, the Alma reached the Faroe Islands on March 29, where we remained till April 12, in order to engage some more fishermen. I will not dwell on the difficulties connected with obtaining the necessary number of men for the Alma and the three fishing-smacks which were to accompany her, as I have described all this at full length in a former report; and I will confine myself merely to mentioning the fact that it was exceedingly difficult to induce the Faroe men to go to Iceland. These difficulties will probably increase from year to year as the Faroe people get more vessels of their own and engage more than formerly in deep-sea fisheries. With a total crew of 16, which in May was increased to 17, we left the Faroe Islands on April 12, and reached Cape Reikianæs on April 17. In Orebacks Bay we noticed some French schooners. These French vessels leave France as early as February, and in the beginning fish along the south of Iceland,

where they leave their traces in the shape of broken barrels, boards, &c., scattered along the coast. The results do not, as a general rule, bear any due proportion to the risk in fishing at this season of the year close to a coast like that of Southern Iceland, without a single place of refuge during a storm. The fishing expeditions from Denmark and the Faroe Islands generally do not reach Iceland till some time during the second half of March.

It had been my intention to begin the fisheries in Faxa Bay, from which place favorable reports had been received; but a severe storm from the northeast drove us out to sea and around the Blind Bird Rocks, and when the storm had abated it took us some time to reach land again, which was not till the 21st, when in the morning we had Kopparnæs to the southwest and Koger in the southeast. Here we reefed the sails with the exception of the mizzen, which is always set during the fisheries as if for sailing before the wind. While the vessel glides over the fishing-place it is necessary that some of the jibs should also be set, so that the lines which run out to leeward may trail out behind the vessel in an oblique direction. It should also be remarked that care must be taken that the vessel does not lie to leeward, whereby the lines, of which half a score hang out along the side of the gangway, easily become entangled.

The sounding-line showed a depth of 70 fathoms. Although it could hardly be expected to find fish at this time and at such a depth, we nevertheless made an attempt to fish, but without success, although in every other respect the conditions of time were as favorable as possible, viz., shortly before sunrise and near the change of the tide. Sailing towards the shore we tried different depths, as it was important for us to know in what direction fish might be looked for, but only at a depth of 40 fathoms did we find any codfish, principally large fish belonging to schools, with a shining white belly, and many of them having fully developed roe. As soon as a wind from the shore drove us to places where the water was 50 to 60 fathoms deep, we only met with halibut, wolf-fish, and occasionally some sharks. The first-mentioned kinds were so plentiful that in the course of a few hours we had from 20 to 30 on the deck of our vessel; of codfish we only caught from 100 to 150 during the first days, which, according to Iceland ideas, is considered a very poor result. Toward the end of the month we had a storm from the north with the temperature a little below freezing, and such a snow-storm that we were compelled to seek shelter in the Talkna fiord, which fortunately was not far off and which was all the more welcome as we remembered that the Bella and the Lovenorn had been lost in 1882 in this very neighborhood, probably because owing to the density of the snow-storm they could not find the proper place for approaching the shore.

The habit, which is unfortunately but too common among the fishermen, of seeking a port during a storm, should as a rule be discouraged as regards fishing-vessels. With the winds which generally prevail on the west coast of Iceland, viz., northeast and southwest, it will be possible

to fish in the shelter of the Fugle bjergene [Bird Mountains] in Brede Bay, or of the Riturhuk and Stigalid (along the deep portions of the Isa fiord), or the North Cape (Shagestrands Bay); especially as, during northeast winds, which generally bring storms in these latitudes, Brede Bay affords excellent shelter; and in this bay the Alma in 1883 twice found a place where she could safely ride at anchor during a storm.

As soon as the storm was over we rounded the Staalbjerghuk and anchored below the Fugle bjergene. In going round the Staalbjerghuk during a strong northeast wind care should be taken to avoid the breakers on the Rosten, a reef running out in the same direction as the Cape Staalbjerghuk, on which many vessels have been wrecked. The best way is either to pass close to the point of the Staalbjerghuk or to go out to sea a few miles before turning. The fishermen generally prefer to do the former. It is best to pass the cape when the storm begins to lull; but I would not advise any one to pass the cape after the storm from the northeast has raged violently for several hours.

There are a good many fish near the reef referred to, but in order to keep near the lines in the wild waves, which sometimes continue for several days after the storm has abated, it often becomes necessary to haul in the mizzen sail, and allow the vessel to be driven out to sea by the current, and even then the lines often become so badly entangled as to exhaust even the patience of a saint.

Until May 5th we had fair weather, and the Alma continued to fish from the Rosten up towards Straumnæs, where we made several good catches of from 300 to 400 large codfish. At the same time the Dyrafiord (one of our fishing-smacks) tried her luck near the North Cape, where fishing was fairly successful in the beginning of May. A few miles to the west of the North Cape the Dyrafiord succeeded in making four or five catches, realizing in all upwards of 3,000 codfish. An Iceland codfish vessel of 38 tons, the Havfruen (built in Kjerteminde, Denmark, in 1879), caught in the same region, on the 3d of May, 950; on the 4th, 954; and on the 5th, 1,208 codfish. It is true that the fish caught on these banks do not weigh as much as those caught on the west coast; while 1,000 west-coast fish will make 7 to 8 skippund [2,240 to 2,560 pounds] klip-fish, the same number of Northland fish will only make 6 skippund [1,920 pounds], but this is amply compensated for by the large number of fish. It was, therefore, a great disappointment when the ice began to interfere with fishing in this locality.

On the 7th of May the Alma unloaded her first cargo of fish at Thingeyre. This cargo consisted of about 2,800 codfish, which, when salted, weighed about 30 skippund, [9,600 pounds], besides about 5 skippund [1,600 pounds] halibut and 2 skippund [640 pounds] wolf-fish. The weight therefore could not be complained of, which made amends for the comparatively small number, and all the more as nearly all the fish were of good size.

After the vessel had been cleaned and thoroughly overhauled, which should never be neglected with vessels which do not have a copper bottom, the Alma left Thingeyre on May 9, after a stay of two days, and sailed for Brede Bay, where, during the remaining part of May, the fisheries were continued, but not with any great success, as severe northeast storms raged nearly all the time. The anxiously expected southwest wind, which is said to be favorable for the fisheries, did not blow often, and only towards the end of July it blew a gale from that direction. It was probably the ice, which with small intervals lies in dense masses along the Northland coast until August, that kept the southwest wind in check. Many circumstances favor the opinion that the fish remain under the ice as long as it lies on the banks, for the ice affords them not only shelter but also light, and finally food, which is carried with it from the polar regions. As soon as the ice left the shore several good catches were made on the North Cape Banks. Thus the H. J. Baago from Svendborg, Denmark, secured 1,400 codfish in a single haul.

In June we had calm weather nearly all the time, and southerly winds prevailed. As the fisheries along the west coast down to Brede Bay had so far been very productive we tried our luck north of the Isafiord, and gradually approached the North Cape, where, on June 10, we came near the ice, which, at a distance of 1½ Danish miles, about 7 English miles, surrounded the North Cape in an immense semicircle from Hælarvigbjerget as far as the Skagestrands Bay, only separated in the middle by a narrow channel. As it was, therefore, impossible to get out to the fishing-grounds, and as the ice was constantly approaching the land, we took a westerly course and stopped at the Koger Bank, where some days previous we had made some good catches. A good fishing-place here is between the Riturhuk and Straumnæs, and between Koger and Husgavlen, where we caught 100 codfish, most of them weighing 50 pounds each and measuring between 4 and 5 feet in length.

On June 12 in the afternoon we noticed several large masses of ice which were drifting towards the shore about half a mile to the leeward. The wind was east. As it had been calm during the preceding days, I thought that they were merely isolated masses of ice which had accidentally drifted in this direction, but when I went up to the foretop I saw, to my astonishment, that the ice had surrounded us and lay in a vast semicircle towards the west, touching the shore at one point and stretching out to sea as far as the eye could reach. We saw several fishing-vessels manage to get through, and as fortunately a fresh breeze sprang up from the east, we embraced the favorable opportunity and slipped out in time. We first sailed in the direction of Straumnæs, and after having reached the edge of the ice we succeeded, after about an hour's sailing, in passing between some enormous masses of ice which presented a strange appearance, having all sorts of fantastic shapes, some resembling porticoes resting on long rows of pillars,

others having caverns whose depths shone in the most beautiful blue and green colors. On the following day the Isafiord, one of our fishing-smacks, slipped through, while the Dyrafiord was kept shut up in Hofn Bay for several days. The remaining part of June we fished along the west land, near Stigahlid, where on the 15th and 16th we sought shelter from a violent southwest wind. We caught a number of fish which were swimming in shoals—so-called herring codfish—most of them containing mature milt. This late spawning probably has some influence on the fisheries, as the fish are not so voracious during the spawning season. The low temperature of the air and water (the latter on an average + 4° R. [41° F.] during June) and the strong current from the land, which is supposed to have had some connection with the unusual quantity of snow in 1883, great masses of water having rushed into the sea when the snow melted, may have been among the causes why there were so few fish on the banks. On June 23 there was a storm from the northeast (temperature of the air, + 2° R. [36½° F.]) near the Fugle bjerge, but this storm lasted only till about noon of June 24, after which day we had fine summer weather (if such on expression can be applied to Iceland weather) all through June and far into July.

A gentle wind and a cloudy sky are the most favorable conditions for good line-fishing, while bright sunshine is unfavorable, as it seems to make the fish lazy. It seems very probable, at any rate, that they would rather snap after something that is alive than after a dead bait—just as other mortals. As soon as the wind had gone down, we chose a position near the Rosten as a starting-point, with an average depth of 45 fathoms. Hence we drifted with the current from Brede Bay in a westerly direction, where we reached a depth of from 60 to 70 fathoms. Here we found mostly torsk and sea-perch, and only a few codfish, most of them small. Owing to a continued calm, we were kept away from the land till the 30th of June, when a wind sprang up from the ENE. which allowed us to reach the coast near the Staalbjerghuk after a sail of about twelve hours. We had been driven out to sea from 8 to 10 Danish miles [about 42 English miles].

During the following days there was scarcely any wind, but, as the fish which had been caught during June must be landed, and as we intended to send letters home by the mail-steamer Laura, it was necessary that we should reach the Dyra fiord (Thingeyre) in a few days. If no wind sprung up, all we could do was to use the current running in a westerly direction; and in this way we managed to reach Sletnæs on July 3, and enter the Dyra fiord the same day. I mention this in order to show the advantages which fishing affords under such circumstances. While drifting along we fished, and near Straumnæs caught about 100 large and fat codfish at a depth of 15 fathoms, within a short time. When the current was very strong, we could not keep a sinker weighing 7 pounds on the bottom.

During the 4th and 5th of July we landed our fish at Thingeyre;

7,312 "torsk-kuller" [haddock, *Gadus æglifinus*] weighed, when salted, 61 skippund, 228 pounds [19,748 lbs.]. On July 6 we left Dyra fiord (Thingeyre) on our last trip for this season, and continued our fisheries the same evening near Kopparnæs.

From this point down to the Fugle bjerge we found principally bottom cod, or "standing cod," as they are also called, with a dirty, gray belly. As a general rule there is more even fishing on banks where the fish make a steady sojourn than in places where one can only count on school-fish, as out near Varden. Of well-known wolf-fish grounds near the Westland, we would mention the region from the Suoudar fiord as far as the Stigahlidsfjeld, the Arnar fiord, and the region between Bjarnanupr and Staalbjerghuk. With a northeast wind we sailed during the following days past Straumnæs, and a strong current from the north drifted us into Brede Bay, which has the reputation of being full of fish. During the forenoon we caught about 200 large, fat codfish, but unfortunately we were becalmed in the bay and could not get out till the evening of the following day. As soon after, when we had proceeded as far as Bjarnanupr, a strong wind sprang up from the northeast, and we had again to seek the shelter of Brede Bay, where we had successful fishing till July 21, when a southwest wind compelled us to leave.

Schools of codfish seemed now to have come to these regions in good earnest, and we made many catches, averaging 500 to 700 fish. Experience has taught me that the whole northern portion of the Brede Bay may be recommended as an excellent fishing-place, especially owing to the fact that the northeast wind is the prevailing wind along the Westland, for during this wind the bay affords good shelter. The bottom of the bay is very uneven and crossed in all directions by numerous furrows, which are the favorite resorts of the codfish. It should also be observed that wherever deep bays interrupt the coast-line, and where several currents meet, the fish will, as a general rule, find good feeding places, and consequently a great number of fish will be found in such places. This applies to the Rosten, the Isa fiord, the bank near the North Cape, near Skagestrand, Grimsey, Langanæs, &c.

The remaining portion of July we drifted with a southwest wind along the shore of the Westland. From Myrakottr, in the middle of the Dyra fiord, and farther east we had good fishing on July 22 at a depth of 50 fathoms—large, fat codfish in schools, and among them a large number of small flounders, which make excellent bait. On the whole, however, the result was not above the average. The July fisheries, which are generally considered the best summer fisheries in these regions, yielded us only about 7,000 fish—about the same number as we caught in May, 1881. On July 29 our little fleet, composed of the Alma and the three fishing-smacks, Dyrafiord, Isafiord, and Patriksfiord, was united at the port of Thingeyre, and the following days we were busy in landing the fish we had caught, taking in salt, &c.

The yield of the Westland fisheries for the four vessels mentioned was as follows:

Vessels.	Salted codfish, ling, torsk, haddock, and sharks.		Salt halibut.	Salt wolf-fish.	Salt ray.	Sounds.		Liver.	Brine-salted keg-fish.
	No.	Weight.	Weight.	Weight.	No	Dried.	Salted.		Fins, gills, &c.
		Lbs.	*Lbs.*	*Lbs.*		*Tons. Lbs.*	*Tons.*	*Tons.*	*Tons*
Alma	19,516	53,656	3,372	5,237	77	4 320	......	9	36
Dyrafiord	16,087	46,235	3,753	5,161	......	......	1	7	32
Isafiord	17,921	49,311	1,677	4,160	......	......	......	6¼	23
Patriksfiord	18,689	50,430	2,795	6,883	12	½	3½	7	35
	72,213	199,632	11,597	21,441					

Of the total quantity of liver at least 4 tons were shark and ray liver; the cod therefore did not yield much liver, one ton of liver being counted to 2,888 codfish = 8,000 pounds salt fish. The livers this year were, moreover, very lean, as we obtained only 1,702 pounds oil from 29¼ tons liver, therefore not quite one-fourth. I am inclined, however, to ascribe some of this to the refining process, for as a general rule 3 tons of shark liver are expected to yield 2 tons of oil, and 2 tons of cod liver 1 ton of oil.

As regards the shrinking of the fish during the curing my own observations have led me to the following result:

Thirty-two thousand pounds of salt fish* yield about 22,720 pounds so-called "yacht-fish" (fish caught from the vessel), with the neck cut; or about 23,520 pounds so-called "yacht-fish," with the neck not cut; or about 22,688 pounds Spanish fish.

Thirty-two thousand pounds of salt halibut yield about 23,040 pounds dried halibut.

Thirty-two thousand pounds of wolf-fish yield about 21,440 pounds dried wolf-fish.

The cutting of the necks yields about 12 pounds of necks per 320 pounds of fish.

During the first days of August we left for the Eastland, there to engage in long-line fisheries from boats. Such has been the custom from time immemorial, and people do not seem inclined to give it up, although it would have been more advantageous if we had limited ourselves to short-line fisheries near the Westland and Northland, and continued these fisheries during September. That the Faroe fishermen, after having in July taken the fish caught at the Westland home to the Faroe Islands in order to have them dried the same year, would not find it advantageous to sail back again to the Westland, can easily be understood; but the Danish vessels, which deposit the fish caught by them on the Westland, should engage exclusively in short-line fisheries.

* By fish I understand codfish, ling, haddock, torsk, and coal-fish.

All the preparations for the long-line fisheries, as well as the trip to the Eastland, generally take up 14 days of the best fishing season, not taking into account that the long-line fisheries involve greater expenses.

On August 3 the Alma left Thingeyre, but did not get out to sea till the 5th, owing to calms and an easterly current. As it had been reported that the ice had gone away from the Northland, it was our intention to go round the Northland in a northerly direction; but when in the evening we reached the Isa fiord, a breeze sprang up from the ENE., and as at the same time the temperature fell to + 2° R. [36½° F.], I thought that the ice was near again, and concluded to go round in a southerly direction, although this made the voyage longer by about 30 miles, and although the current was not favorable. We heard later that the Dyrafiord was forced to turn near the North Cape, and that the Patriksfiord escaped the ice only by sailing all the way down to Skagestrands Bay. Cape Reikianæs was passed on August 7th, Portland on the 10th, but after that we were becalmed and did not reach the Nord fiord till August 14. When we arrived we found 9 other codfish vessels. The first of these had come here in the beginning of the month, and had been successful, catching a good many large and heavy fish. There were here also some Norwegian vessels waiting for the herring, and Svend Foyn with his little steamer Gratia. He was superintending the erection of a large oil refinery. The long-line fisheries are carried on in the following manner: While the vessel lies at anchor in the fiord watching the herring nets, the crew are sent to sea in boats (20 to 24 feet long, built at the Faroe Islands), 3, 4, or 5 men being assigned to each boat, according to their size and the condition of the weather. On account of the currents the Faroe fishermen prefer a line which is not too long, having from 300 to 400 hooks, but which is drawn more frequently than longer lines. The fishermen of Denmark often use lines having 1,000 hooks. For bait are used fresh herring, halibut, wolf-fish, &c., and the baiting is done while the boat is being rowed out of the fiord. Our Danish fishermen would find it somewhat difficult to get accustomed to this mode of baiting, as in Denmark this is generally done by the "girls" before the boats leave the shore. Besides the Nord fiord the following fiords in this neighborhood are considered good codfish stations: Reyder, Faskrud, Bern, and Vapna fiords; and in the beginning of the season, Borgar and Bakka fiords.

The O fiord is doubtless a place which would make a good codfish station. It is one of the best herring inlets in Iceland, and it is well known that the codfish always follow the herring, which latter are also of importance as bait. The reason why no cod-fisheries have been attempted in the O fiord is probably this, that the Faroe fishermen, after having returned from their trip to the Faroe Islands, always choose the nearest fiords. For Danish vessels, however, it would be worth while to attempt cod-fisheries in the O fiord.

English fishing-smacks are in autumn generally engaged in fisheries

near Langanæs and Grimsey. The line-fisheries for school codfish, which go after the herring at a depth of 50 fathoms, are principally carried on near Langanæs. Some of these fishing-smacks towards the end of the season fill their tanks with live fish, which they sell in England, where fabulous sums are often paid for large live codfish and halibut.

The newly-built Norwegian fishing schooner Gunguer, from Tonsberg, built at Framnæs, near Sande Fiord, on the American plan, was last year engaged in the cod fisheries near Iceland. She was said to be owned by Svend Foyn, and as she came to the Nord fiord during our stay there, I had an opportunity of examining her. Her tonnage was 62; length, 80 feet; drew water 10½ feet aft, and 8 feet forward. The rigging, fore and aft, was that of a schooner, with masts 70 feet long, and the hull was beech at the bottom, oak at the top, fastened with copper. Fully equipped, and with all the necessary fishing apparatus, she had cost 24,000 crowns [$6,432]. She had 6 dories, 3 of which were fitted exactly within the other 3, so as to take up but little space. In the hold of the vessel there was a cabin, a forecastle for the sailors, a salt-room, and a bait-room, with an ice-room on each side, so that bait can be kept fresh for a long time. It had also been intended to place on board a steam oil-refining apparatus, so that medicinal oil could be prepared, as is done on most American vessels. The Gunguer had a crew of 14 Norwegians, who fished alternately with the hand line and with the long line, according to circumstances. When the long line is to be used, the vessel remains at anchor near the fishing station, and the dories go out, each with two men, but never very far from the vessel. Each boat has 1,000 hooks fixed on the American plan.

From the 14th to the 29th of August the Gunguer had caught about 8,000 codfish and about 5,000 pounds halibut. The latter (like the codfish) had been dry-salted, but it was the intention on returning to Norway to wash them and smoke them, making an article which is said to find a ready sale in America at 12 cents per pound. The Gunguer had fished all along the coast of the Northland, especially near Grimsey and Rodehuk (southwest from the Huk at a depth of 50 fathoms), and had come to the O fiord to secure a supply of fresh herring for bait. The above yield must be called very good, considering that the crew was small and inexperienced. It may be well to direct attention to the fact that these 14 men could fish with 5 or 6 boats, using 5,000 or 6,000 hooks, while our 18 men could only man 4 boats with about 1,500 hooks. Herein the Americans show their superiority, as they thoroughly understand how to use human strength in the most reasonable and economical manner.

Our fisheries came to a close on October 7, when the Alma left the Nordfiord. All in all, our fisheries had been interrupted for five days on account of stormy weather. The fish from all the 4 vessels were landed on the Faroe Islands to be dried there in the coming spring.

The result of the Eastland fisheries was as follows:

Vessels.	Salt cod, haddock, ling, torsk, and coal-fish.		Salt fins, gills, &c.	Liver.
	Number.	Weight.		
		Pounds.	*Ton.*	*Kegs.*
Alma	27,427	40,347	1	$9\frac{1}{2}$
Dyrafiord	32,000	51,066	....	8
Isafiord	26,642	36,848	....	7
Patriksfiord	26,172	42,200	1	9

Of the entire quantity (176,461 pounds salt fish) there were large fish, 50,880 pounds, or about 30 per cent; small fish, 79,360 pounds, or about 46.5 per cent; haddock, 36,480 pounds, or about 21.3 per cent; coal-fish, 3,840 pounds, or about 2.2 per cent.

The quantity of liver was, therefore, about 2.2 per cent of the weight of the fresh fish, one ton of liver being yielded by 2,400 codfish. Of the entire quantity of liver ($33\frac{1}{2}$ kegs) $27\frac{1}{2}$ were landed on the Faroe Islands, and yielded 8 kegs of oil. The proportion was, therefore, two-sevenths, not much better than in the Westland fisheries, taking into consideration the greater fatness of the livers.

As regards the quantity of salt used, the result of my experience is as follows:

In 1881 I used for 83,840 pounds of cured fish 305 tons of salt, or $1\frac{1}{2}$ tons per each 320 pounds.

In 1882 I used for 66,240 pounds of cured fish 264 tons of salt, or $1\frac{1}{6}$ tons per each 320 pounds.

In 1883 for 291,200 pounds of cured fish 1,300 tons of salt, or $1\frac{1}{3}$ tons per each 320 pounds.

The salt used during these three years was exclusively Liverpool salt, and I always counted 265 pounds of fish to a ton of salt. I should mention, however, that in 1883 the salt was too fine and therefore too weak, and turned to brine too rapidly. Some people prefer St. Ives salt, which is more expensive but coarser.

The total result of the Alma's Iceland fisheries in 1883, when salted, therefore represents a weight of about 106,350 pounds, which quantity of fish, when fresh (with the head and entrails), would be $2.7 \times 106,350$ pounds $= 287,145$ pounds, my observations having shown that the shrinking during the cleaning and while in the salt is $\frac{17}{27}$, leaving but $\frac{10}{27}$ of the original matter.

An average price of 7 ore per pound would therefore yield a gross income of 20,100 crowns [$5,386.80], while the actual income will only be about 16,000 crowns [$4,288]. Such a price for the fresh fish would correspond to 28 ore [between 6 and 7 cents] per pound of klip-fish, while 20 ore [about 5 cents] must be called a good average price for fish bought at first-hand.

One of the principal objects in developing our Iceland fisheries, therefore, should be to get the fish into the market in fresh condition; and all that is needed for this purpose are frequent and rapid means of communication.

For the sake of comparison between the quantity of fish in the North Sea and the Iceland waters, I will state that the average yield counted on by an English fishing-smack in the North Sea is 14,000 pounds per month, while the Alma in 1883, which was considered a poor fish year, caught about 48,000 pounds fresh fish per month near Iceland. That in trawl fisheries only 6 men are needed, while the Alma had 17, is of little importance; the principal point being that the capital invested should yield a reasonable interest.

But even apart from the question of fresh fish, I maintain that the cod-fisheries near Iceland can be very remunerative for our small sailing-vessels, and that, therefore, they should be of special interest for owners of such vessels. All that is needed is to get experienced men, especially captains, and to take account of all the products of the fisheries, not merely of the codfish alone, and put them to the best possible use. If once an interest is awakened in these fisheries, the Government will not be slow to extend its aid by publishing good maps, &c. The manufacture of medicinal oil on board the fishing-vessels, as well as the preparation of isinglass and other products from the fresh, undried sounds are probably among the subjects which should first of all be carefully studied by competent men.

There is hardly any doubt that the Association for the Promotion of the Fisheries in Denmark and its Colonies, which, it is hoped, will in the near future begin activity, can do a great deal towards the satisfactory solution of such problems; and it is therefore desirable that every one who takes a direct or indirect interest in the promotion of the sea-fisheries, will soon join this association, as its power for good will to a great extent depend on the number of its members.

XIII.—THE FISHERIES OF INDIA.*

By Francis Day, F. L. S., F. Z. S.,
Deputy surgeon-general (retired), formerly inspector-general of fisheries in India.

The subject which I shall have the honor to bring before you this evening is that of the fish and fisheries of India and its dependencies. Possibly there are other questions pertaining to the East which would prove more attractive and likely to engage attention than fish; but I think there is not one which could be selected more directly interesting to the teeming millions of our Indian Empire, and which requires so much investigation from our legislators, philanthropists, and scientific inquirers.

Origin of fisheries.—Doubtless one, perhaps the greatest, reason why many persons take an interest in this class of the vertebrate animals consists in the food they afford, and the occupation they give to man. But when we consider the subject more closely, we find that in our everyday life we are profiting extensively from the lessons which our ancestors received from the finny tribes. Man, in his savage condition, has the natural instinct of desiring food when hungry. Whether he can or cannot subsist solely upon vegetables is immaterial; his canine teeth demonstrate his carnivorous propensities, and, nauseated with a vegetarian diet, he would naturally seek change by the addition of animal substances. If living near water, more especially on the sea-coast, the hungry savage would first resort to such mollusks, crustaceans, and fish as he could capture in the shallows, or were left there by a receding tide; but as his wants increased, and the source of supply began to diminish, he would have to adopt other devices. He would wade after his prey, pursue them with spears, shoot them with bows and arrows, as the Andamanese do to this day, obtain them by setting up dams and weirs, or intoxicate them with poisons.

But, again (unless consequent upon some peculiar circumstances), the time would inevitably arrive when augmented captures would be desired; man would then have to venture further out, to dive after his prey, employ nets, to float upon a log, or fasten pieces of wood together as a raft, and in due succession would come the construction of a boat, and finally that of a ship—this last being necessary for the purpose of

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extending his range to better fishing-grounds, or exporting his spoils to distant markets. Consequently, the basis for navigation and commerce may reasonably be supposed to have been laid by man pursuing the finny tribes for the purpose of obtaining them for food, or conveying them dried or cured as an article of merchandise to transmarine countries. The very history of sea fisheries, which have been free to all, seems to point out that, as man increases in numbers, inshore captures of fish becomes insufficient for his requirements; or else that continuous fishing may diminish the supply, rendering it equally necessary that the fisherman's occupation should be extended to more distant localities.

A.—FRESHWATER FISHERIES.

Freshwater fisheries differ in many respects from marine ones; and we are all aware that, wherever any quantity of fresh water exists in the East, there we are almost certain to find fish; and this from a sea level to nearly the summit of the highest mountains. As a natural result, fishing is had recourse to, in various ways, in rivers, irrigation canals, lakes, tanks, ditches, inundated fields, and swamps. The importance of such fisheries is not solely in a ratio as regards their productiveness, but also in accordance with the character of the adjacent people as to whether they are or not fish consumers; while the sparseness or the density of the population has also to be taken into account.

Where no regulations are in force for the protection of inland fisheries, and should other circumstances be equal, that country or district which is most densely populated by man will be least so by fish. Individuals would rather live by fishing than by agriculture, because the trouble of capturing the finny tribes is less than that of tilling the soil. It becomes simply catching food, without a thought respecting future supply. Fish have been endowed with certain means of increase and protection; the number of their eggs may be enormous, while some forms keep guard over their eggs and likewise over their fry, in order to afford them protection from their enemies.

As, however, man increases, watery wastes (wherein the fish had been protected by grass, reeds, bushes, and the roots of trees) become drained and cultivated; predaceous man increases his means of destruction; an augmented population, possibly assisted by the unscrupulous manufacturer or miner, pollute the previously wholesome water, and a diminution of the finny tribe becomes apparent to the investigator.

With an increasing fish-eating population an increased supply of fish thus becomes a self-evident necessity, and this must be provided for by augmented captures or higher prices; the latter acting as a check on the poor, by more or less placing it out of their reach. This latter result may, consequently, eventuate in gradually diminishing the physical strength of the people. For a greater supply must be had from one of two sources, either from fisheries which previously have been insufficiently worked, or by overworking such as exist, by means of capturing

for present use those which ought to be left for a future season. Even if the extent of the water is so great, and the inhabitants so few, that this result need not be anticipated for several generations, still, populations under good systems of government have a natural tendency to increase. Means of carriage generally improve with time, and should neither regulation nor care of the fisheries be attempted, disastrous results must eventually be arrived at. Fish appear to have few friends and many enemies, and investigations as to their condition generally ends in giving increased license to their captors, for it is so easy to be liberal at other people's expense. We see interested parties and philanthropists (so-called) exclaiming against the hardship to the poor in not allowing every available fish to be secured. The majority of our law-makers are content to allow the fish to shift for themselves, and to leave the fishermen to be controlled simply by their own consciences. To-day's market, it is hoped, will be supplied; sufficient for this season, it is expected, may be obtained; so let to-morrow's wants be met as they can.

Classes of Indian fishermen.—The fishermen of the fresh water of India and Burma are divisible into two main classes: first, such as follow this calling as their sole means of livelihood; and, second, such as enengage in it only occasionally, and as a subsidiary occupation. Who, then, are these Indian fishermen? Here, even within the limits of a single,or at least of a few generations, great innovations have crept in; for in the time of native rule, fishing was in the hands of distinct castes, but now it is only here and there that one comes across some remnants of these people, living in small communities, and frequently in the greatest poverty. At Combaconum, in Madras, there is a tradition that the fishing castes resident there were originally brought from Conjeveram as palanquin bearers, while at Broach, in Bombay, two subdivisions of these people are named in accordance with the villages from which they originally migrated.

Present decrease of fisheries.—In native states, fish have obtained great consideration. Thus in Mysore, in the time of Hyder Ali, very stringent fishery laws existed; whereas, at the present day, about two-thirds of the population of some divisions of the country occasionally add fishing to their other occupations, nearly every villager possessing a fish net or trap, to be employed as occasion or opportunity arises. Now fisheries are open to all; a fisherman's calling is no longer a profitable one, mainly due to the fisheries being depopulated. When whole districts were let to contractors, they were not so short-sighted as to permit an indiscriminate destruction; but now everybody does as he likes, when he likes, where he likes, and how he likes. Thus it has come to pass that among the animal productions of India, freshwater fish meet with the least sympathy and the greatest persecution; many forms having to struggle for bare existence in rivers which periodically diminish to small streams or even become a mere succession of pools,

or in tanks, from which the water totally disappears. They have their enemies in the egg stage, in their youth, and during their maturity; but among these man is their greatest foe, as any one who desires a fish diet captures these creatures whenever and wherever he gets the chance, irrespective of season, age, and size. In certain districts they simply appear to exist solely because man and vermin have been unable to destroy them.

Fisheries may be let to a contractor, and if their extent is large he takes partners or sublets portions; sometimes he employs servants, who are paid partly in money, or food, clothing, and lodging, and partly in a share of the captures. In some districts the fisheries, or a portion of them, are declared free, but a license fee is charged to the fishermen; or the general public is free to take fish for home consumption, but not for sale. Lastly, no regulations at all may exist, due to the general poverty of the fisheries, peculiar difficulties in their capture, or the general impecuniosity of the inhabitants.

When the public have more or less depleted fisheries, the fishermen become poorer and poorer, unless they turn to other sources of obtaining money; at first, no doubt pleased at the remission of rents, and the removal of all restrictions upon fishing, they employ redoubled energy, and thus augment their immediate profits. But soon the general public find that nothing precludes their fishing in any way they please; the markets become glutted, and the price may fall for the want of purchasers. But after two or three years fish become scarcer; fishing is no longer remunerative; removing the rents from fisheries and throwing them open to the public will not decrease the price of fish. The rates ruling in India are comparative to what obtains for meat and other articles of animal food. Fishermen, living on free fisheries, do not dispose of their capture below market rate, any more than farmers who possess rent-free farms sell the produce at less than their neighbors. If the fisherman benefits, the purchaser does not, and their misapplied energy eventuates in nothing but small fish remaining. The young have to be raised from ova of such as are merely one or two seasons old, while the younger the parent the smaller the eggs, and this, I believe, is one mode in which races of fish may deteriorate.

Natural and artificial causes affecting fisheries.—The rivers which have alpine sources, as such as descend from the Himalayas, have, exclusive of springs, two most abundant sources of replenishment. During the hot months this is derived from melted ice and snow, while during the monsoons the rains assist; we may then have the hill rivers forming torrents, rising rapidly, and as rapidly subsiding, and possessing no contiguous tanks into which the fish could retire. These animals are peculiar, or endowed with means of existence differing from such as live wholly or mostly in waters of the plains. Many of the fish are provided with adhesive suckers, situated behind the lower jaw or placed on the

chest, which enable them to fix themselves against rocks, and so prevent their being washed away by the stream.

Through the cold months, and generally until the setting in of the southwest monsoon in June, rivers are at their lowest, some at this period (especially in hilly regions) being merely a succession of pools, united by a more or less significant stream, in which limited localities the fish take refuge, and may be easily secured by fishermen.

Among the artificial causes affecting fisheries in many districts are the irrigation works, which are formed by throwing a weir or bund across a river, and diverting a large amount of its water down a main irrigation canal. These weirs are usually built as stone walls across the entire breadth of the rivers, and consequently impede both the upward and downward passage of fish that are endeavoring to migrate, while, should they be sufficiently high, they entirely stop them. Where large under-sluices are present, fish can pass up such when open; but up the long narrow ones, as constructed in Madras, the strength of the current renders this impossible. The under-sluices are here closed, except where there is an excess of water, as during the monsoon months; and as the weirs have no fish-ways, not only is ascent towards the breeding-grounds intercepted, but fisherman are permitted to capture the fish which are detained here. Standing on those weirs, one can see the fish jumping against the obstruction, which they vainly hope to surmount; some strike against the piers of the bridge, others fall into the cascades, descending over its summit; but to them the wall is an impassable obstacle.

The irrigation canals may be said to be streams obtained by diverting a large amount of water from a river into a new channel, and this, of course, would be taken from above the weir; consequently, all fish descending the river would be diverted into the irrigation canal. If these canals are constructed for navigation as well as for irrigation, the fish can pass along them; but if due to falls, they are unsuited to navigation, then the fish can descend them, but are unable to reascend. They then become vast fish-traps, wherein all the finny inhabitants are destroyed whenever the canals are run dry in order to examine their condition and see what annual repairs are necessary. Passing off on either side of these canals are lateral irrigation channels, which are employed to water the crops directly, and at each successive replenishment of these another shoal of fish passes to inevitable destruction. Unprovided with gratings at their entrance, and kept filled only on alternate weeks, all the fish which enter invariably perish. The same destructive process exists throughout India wherever irrigation is carried on.

As the yearly rains cause inundations of the country by the overflowing of the rivers and tanks, fish move about in order to find suitable localities for breeding in, and the small streams and their outlets resemble the net-work of irrigation channels. Many species ascend them to to spawn, but find at every turn appliances invented by man ready for

their destruction. Persons may be watching to intercept them, engines or traps may be fixed in their course; or, should any breeding fish succeed in effecting their ascent, means are taken to insnare them on their return, while the fry are destroyed in enormous quantities—a proceeding which has been declared not to be waste because they are eaten.

Then there are tanks, some of which are, others are not, in connection with running water. Should they entirely dry up during the hot months, only such fish as bury themselves in the mud will survive to the next rainy season. As a rule, the owner of a tank, if it is employed also for fish-culture, leaves one portion (the deepest) in order to retain sufficient water to keep the finny residents alive, while, if very hot, boughs of trees or tatties are placed over this locality to mitigate the heat.

I shall now pass on to consider the fishes inhabiting the fresh water of India, Burma, and Ceylon. They may be divided into (1) those which enter from the sea for breeding or predaceous purposes, and (2) such as, more or less, pass their lives without descending to the salt water. The first class I do not propose giving any detailed description of, unless casually remarking upon such when the breeding of fish or the fisheries come under review.

Varieties of freshwater fish.—An exhaustive account of all the strictly freshwater forms would doubtless be interesting scientifically, but hardly so to the fisherman or general reader; consequently I shall restrict myself to observing that the fisheries alluded to contain about 369 species, appertaining to 87 genera. Of the spiny-rayed, or *Acanthopterygian* order, we have 19 genera, the members of which are most numerous in the maritime districts and deltas of large rivers, while their numbers decrease as we proceed further inland. Few are of much economic importance, if we except the common goby, spined-eels (*Mastacembelidæ*), the snake-headed walking-fishes (*Ophiocephalidæ*), and the labyrinthiform climbing-perch and its allies.*

Of the sheat-fish, or scaleless siluroids, we have 26 genera. The mouths of these forms are provided with sensitive feelers, which, serving as organs of touch, assist them while seeking their prey in turbid waters. All that are of sufficient size are esteemed as food, although, owing to their propensity for consuming unsavory substances, their wholesomeness appears, at times, to be questionable. The next 3 genera, gar-pike (*Belone*), Cyprinodon, and Haplochilus, are of but little value, but the 35 genera of carps and loaches are of the greatest possible consequence, affording a large amount of food to the population of the country. The remaining 4 genera, consisting of the curiously flattened *Notopterus* and 3 forms of eels, are of but little mercantile importance.

* These air-breathing fishes are of great economic importance; thus, when poisonous ingredients are washed into rivers, on the first burst of the monsoon, the fishes die, unless they are direct air-breathers, taking in atmospheric air direct, when they are often able to exist until the poison has passed down stream.

1.—Reproduction of fish.

How the reproduction of these fishes is carried on becomes a most necessary investigation, and in briefly considering such we might inquire into what migrations they undertake for this purpose? Whether the parents are monogamous, polygamous, or are annuals, dying after the reproductive process has been accomplished? The time of year when spawning occurs? Whether such is or is not deleterious to the parent? The size of the eggs, their color, whether they float or sink, are deposited in running or stagnant waters? If they are covered or left uncovered in their nests? If the male carries them about or protects them? Can their germination be retarded by artificial means or natural causes, as by the action of cold or their immersion in mud?

Migration of spawning fish.—That anadromous forms, as the salmon or shad of Europe, or the shad (*Clupea palasah*) of India, migrate from the sea to the fresh waters to deposit their eggs in localities most suitable for their reception is well known. If we examine into the migration of Indian fishes for breeding purposes in fresh waters, we find that such takes place under three conditions, viz.: (1) Anadromous forms from the sea to the fresh waters, as already adverted to; (2) Such species as may be considered pertaining to the mountains, or else deposit their ova in the rivers of the hills; (3) Such as are restricted to the plains, but which likewise undertake certain changes of locality at these periods. Of the migratory hill-fishes the various forms of large barbels (*Barbus*), termed *mahaseers*, furnish good examples. In the Himalayas they ascend the main rivers, but turn into the side streams to breed, while on the less elevated Neilgherry Mountains, in the Madras Presidency, the same phenomenon occurs, but with this difference, that they deposit their ova in the main streams because such are small, and perhaps due to their never being replenished with snow-water. Occasionally the fish are too large to ascend these mountain rivers, when they would appear to breed at the bases of the hills. Whether it is from the offspring of such that this genus has extended through the plains it is not my purpose to inquire in this place. When the rivers commence being in flood, adults are able to ascend to feeding-grounds which were previously inaccessible to them. Having spawned, they keep dropping gently down stream, during which time the amount of water is diminishing; thus the ova, when hatched, are completely cut off from the locality where their parents reside, precluding their making a meal of them. The fry, therefore, have the heads of the rivers to themselves in perfect security, and each torrent becomes transformed into a small stream intersected by pools, where they can remain until the next rain enables them to descend to the larger rivers. Of the migratory fishes of the plains we may observe many forms of carp, and this is more particularly observable where impassable weirs exist in Indian rivers; here they may be perceived in attempting to jump over the obstruction, and so common

is this phenomenon that the natives of India hang baskets, cloths, even native cots turned upside down, or anything equally suitable, over the sides of the piers, and into these the fish fall.

Monogamous and polygamous fish.—In Asiatic waters we have monogamous and polygamous forms and other phenomena as to breeding, which deserve attention. The walking, or snake-headed fishes (*Ophiocephalidæ*) of India, and other amphibious genera, are perhaps the best known of monogamous fishes; some of them reside in ponds, others prefer rivers, where they take up their residence in deserted holes which they find in the banks. The pond species delight in lying at the grassy margins, where the water is not deep enough to cover them, and here they are able to respire atmospheric air direct. The striped walking-fish constructs a nest with its tail among the vegetation, and bites off the ends of the waterweeds; here the ova are deposited, the male keeping guard; but should he be killed or captured, the vacant post is filled by his partner. The hissar, *Callichthys*, of South America, is likewise monogamous, constructing nests, which it also defends. The majority of fishes unquestionably are polygamous, as has been repeatedly observed, and, perhaps, as distinctly among the salmon as any other form in a wild state, and likewise in sticklebacks resident in aquaria; while, doubtless, fishes which migate in shoals for breeding purposes, as the mackerel, herring, or some forms of carp, are all polygamous.

Time of spawning.—The time of the year at which spawning is effected varies in accordance with the locality and the family of fish. This again appears to be further susceptible of modifications in accordance with the temperature of the water, and many other local causes, while there are some fishes which breed only once a year, others more frequently. I must here premise that some fishes do not appear to feed during the season of depositing their spawn, as the salmon, the shad, and the siluroid *Ariinæ*. In India an anadromous shad, termed "Pulla" in the Indus, "Ulum" by the Tamils, "Sable-fish" by the Madrasees, "Palasah" by the Telingis, "Hilsa" or "Ilisha" in Bengal, "Nga-tha-louk" by the Burmese, breeds in rivers as already described. In Sind they ascend the Indus in February to spawn, descending in September. In the Cauvery, in Madras, they pass up when the first burst of the June monsoon fills the river, and they continue doing so for the succeeding four months. In the Krishna, which has a far greater velocity, but, similarly to the Cauvery, is filled in June, they defer their ascent until September, but it is not until the end of the month or commencement of October, when the river is subsiding and its velocity decreasing, that the majority arrive; whereas in the neighboring river, the Godavari, in which the current is less rapid, these fish ascend earlier to spawn, being most numerous from July to September. In the Hooghly they continue ascending throughout the June monsoon, and many are found still in roe in September. The main bodies of these fish ascend the

large rivers of India and Burma generally when the June monsoon commences, but not always at the same period, such apparently at times being dependent upon the rapidity of the current and other causes. That it is not due solely to the presence of rain-water flooding the river is evident, because those of the Indus and Irawadi are mainly caused by melting snows at this period, and likewise in the latter river these fishes push on to Upper Burma, to which country the monsoon scarcely extends, but where the inundations are due to snow floods. Probably the cause of the majority of fishes at these various periods ascending the different rivers to spawn may be due to their having been bred there, while inherited instinct causes them to select the most suitable times, when the shallows are covered with water and ascent is rendered practicable. It is evident that members of the same family, genus, or even species, may spawn at very different periods, due to local or climatic causes. There are also fishes which deposit their ova twice yearly, if not more frequently; these are generally freshwater forms, and are not rare, especially in tropical countries; as an example we have the walking-fishes.

Effect of spawning on parent fish.—Has spawning any deleterious effect upon the parent fishes? To this, two replies may be given, as in some cases it renders their flesh unwholesome, while in others it does not cause their character as to food to be altered. The shad in the East are excellent eating up to the period when they have deposited their eggs, subsequent to which they become thin, flabby, and positively unwholesome; the salmon have similarly an unhealthy lean and lank condition, rendering them unsuitable for the table. Freshwater fishes that deposit a smaller number of eggs, or, perhaps, do so more gradually, or twice at least during the year, do not invariably appear to be so deleteriously affected by breeding, this condition being more restricted to the anadromous forms.

Size, color, and protection of eggs.—The size of the eggs, their color, and whether deposited in ponds or in the sea, are likewise questions affecting the breeding of fish. The forms which produce the greatest number of eggs are often those which live in large communities and spawn once a year. In an Indian shad I found 1,023,645 eggs. But other forms have likewise numerous eggs. I oberved 410,500 in a barbel (*Barbus sarana*); on the other hand, some fishes have large eggs, as a few of the sheat-fishes, and a genus of carp (*Barilius*). In such as spawn at least twice a year, and likewise protect their young, the number of eggs is less than what generally obtains in other genera; thus in a walking-fish (*Ophiocephalus*) I found 4,700.

As to the color of fish eggs, they are very diversified; in some freshwater siluroids they are of a light pea-green, as I have observed in the scorpion fish (*Saccobranchus fossilis*). Respecting the localities where fish deposit their eggs, these are exceedingly various, as might be anticipated, owing to some sinking in the water while others float. The

gar-fish (*Belone*), and the flying fish (*Exocœtus*), have filaments springing from their eggs for the purpose of attaching themselves to contiguous objects; others are covered with a glutinous secretion. In fresh waters eggs may remain at the bottom, either covered or uncovered.

Among the marine siluroids (*Ariinæ*), the male carries about the large eggs in his mouth until hatched; or it may be that he only removes them from one spot to another to avoid some impending danger. However this may be, I have netted many along the seacoast with from ten to twenty eggs in their mouths, and in one example was a young fry just hatched. In none of these large males was there the trace of any food in their stomachs.

Artificial hatching and transportation.—Bloch, at the end of the last century, made many experiments as to the feasibility of fish being artificially hatched, and also whether it was possible to convey the ova in safety for any considerable distance. He proposed placing the eggs of pond fish in mud, similar to that existing in the locality from which the eggs were procured, and he believed that when the mass had dried they could be thus removed without injury from one pond to another. His proposal was based upon the theory that frequently on dried-up ponds being refilled with water, young fish appear, which could only be due to the eggs having been present in the mud, but with their germination suspended. In India, as ponds dry up, some of the fish contained therein descend into the mud, where they estivate until the next year's rains set in. As these commence, and the mud liquefies, fish are perceived diverging in all directions, up every watercourse, no matter how small or how lately it may have been dry, while in a few days fry are distributed everywhere. Where the eggs come from which have produced these fry is a very interesting subject for investigation. Have they remained inside the mother fish, and did she deposit them as soon as the rains set her free? I cannot accept this theory, because I have witnessed fish removed alive from the mud, but they had no ova; and, secondly, because the fry are soon hatched after the setting in of the rains, while some of these fish are oviparous. It seems more reasonable to suppose that the fertilized eggs are imbedded in the mud, and, as soon as the rains occur, they become hatched out, and this would give us reason for attempting to ascertain whether ova of pond fishes imbedded in mud could be successfully transported long distances.

We know that germination of fish eggs can be retarded by cold. In fact, by the use of ice, those of trout and salmon have been safely conveyed to Tasmania and elsewhere.

2.—Legislation on fisheries.

Royalties and licenses in former times.—From the information collected between 1869 and 1873, it appeared that the fisheries in olden times were royalties, mostly let out to contractors, who alone in their respect-

ive districts possessed the right to sell fish, while they, as a rule, permitted the people, on payment, to capture sufficient for their own households. In was, in fact, a license on payment, resumable at will. Remains of this custom still exist in Lahore, while the leasing of fisheries is even now in force in many portions of the Indian Empire. Along the Himalayas, in the Kangra and other districts, the petty rajahs adopted a different method. To some persons they gave licenses to supply the fishmarkets, of which they virtually made them monopolists, while others obtained licenses for fishing with small nets for home consumption, but not for sale. In Burma, under native rule, a similar plan was carried out. There were no free fisheries, but inhabitants had the privilege, or perhaps right, to fish for home consumption on the payment of a fixed annual sum to the contractor for the district in which they reside. It is believed that under native rule the erection of fishing weirs was permitted in several of the streams in the Himalayas, but not to the extent that it is at the present day. In some districts landowners even now raise an income from the fisheries, claiming a third of the captures or a certain amount of money. Some of our officials consider that as the Government has permitted indiscriminate fishing, the exercise of long practice has converted such into a communal right.

Fishing under British rule.—As British rule has gradually superseded that of the native princes, so the modes in which fisheries were leased have become widely different, and in permanently settled estates, unless a stipulation to the contrary exists, they go with the land. In some localities it has been decided that the adjacent villagers or people possess certain communal rights with respect to them, due, it seems most likely, to a misapprehension. Although it has been proved that the landowner never received more than one-third of the produce, this does not demonstrate that the other two-thirds were public property, but that such expressed the share accruing to the fisherman in return for his labor in capturing the fish. It is the rule in India and Burma to remunerate by the proceeds. Sometimes the working fisherman has to dispose of his share to the contractor or lessee at a given rate; more rarely the fish are sold, and he receives a proportion of the returns, or he may be paid in kind. In some localities the British Government has leased fisheries, or imposed a tax on the implements of fishing, or a capitation tax upon the fishermen, but without interfering with the manner in which the fisheries were conducted. By degrees the tax on fishing implements was taken off, but the fishermen still became poorer, and in 1849, at least in Madras, many leased fisheries were thrown open to the public, resuiting, as they were not regulated, in unliminated license, and thus an intended boon resulted in their depopulation. In Burma, the practice of employing fixed engines in irrigated fields and watercourses very largely increased when the native regime became abolished, as did also the custom of throwing weirs across creeks and minor streams.

Injury caused by free fishing.—Free fisheries have been permitted, due to several causes, such as the difficulty in making such sufficiently remunerative to bear taxation or the incidence of rent. This may be owing to the rapidity of the current, the paucity of fish, as in some hill streams and depopulated rivers, the depths of tanks, the presence of foreign substances in them, or the poverty of the general population. How general and indiscriminate fishing ruins fisheries, without any commensurate benefit accruing to the public, I have already stated. In these deteriorated but public fisheries, as soon as the monsoon has set in and the fry are commencing to move about, women and children are daily engaged in searching for them in every sheltered spot where they have retired for security, as, not being able to face strong currents or live in deep waters, they naturally resort to the grassy but inundated borders of rivers and tanks. Every device that can be thought of is now called into use; nets which will not let a mosquito pass are employed; even the use of cloths may be frequently observed. Neither are the agricultural population idle. They construct traps of wicker-work, baskets, and nets; these traps permit nothing but water to pass, and a fish once inside is unable to return, as they resemble some of our commoner kinds of rat-traps. So soon as fish for the purpose of breeding commence passing up the small watercourses at the sides of rivers and streams, these implements of capture come into use; breeding fish are taken, and the few which surmount the obstructions find the traps reversed, so that, although they have ascended in safety, it is by no means improbable that their return to the river will yet be cut off. In Burma a large triangular-shaped basket is employed in places where trapping is difficult, and a pair of buffaloes having been harnessed to it, it is dragged through the localities inhabited by the fry. Even when there are no restrictions, fishermen often find it advantageous to ply their occupation in concert. Sometimes large bodies of villagers proceed at certain seasons of the year to rivers which can be easily bunded, having done which, they kill every fish they are able.

Size of the meshes of nets.—In investigating what is the minimum size of the meshes of the nets in general use in India and Burma (excluding Sind), where no regulations exist declaring what such should be, I received the following replies from ninety-one native officials:

Five native officials report 1 inch as the size between knot and knot of meshes; five report below 1 inch; eighteen report one-half inch; five report one-third inch; twenty-four report one-fourth inch; one reports one-fifth inch; five report one-sixth inch; eighteen report one-eighth inch; four report one-tenth inch; two report one-twelfth inch; three reports one-sixteenth inch; one reports one thirty-second inch. And out of seventy more returns, fifty-three officials compared the size of the mesh to a grain of wheat, mothi, mucca, gram, dholl, lamp-oil seed, barley, tamarind seed, a small pea, a peppercorn, a large needle, a bodkin, quill, coarse muslin, will insnare a gnat, or hardly anything passes. The

remaining seventeen described the smallest size as follows: Size of finger or thumb, five; of half ring-finger, two; as big as a broomstick, one; size of half rupee, one; of a four-anna bit, one; of a quarter of an anna, one; of a two-anna bit, five; of a pie, one.

Fixed fishing apparatus.—The fixed engines employed in India and Burma are mainly divisible into two forms: (1) Those manufactured of cotton, hemp, aloe fiber, coir, or some such material; and (2) others constructed of split bamboo, rattan, reed, grass, or some more or less inelastic substance. Those which are manufactured of elastic substances include all stake-nets, but when the meshes are of a fair size they are a legitimate means, when properly employed, for the capture of fish, but are occasionally to be deprecated, especially when used solely to take such as are breeding. But in some of these implements the size of the mesh is so minute that no fish are able to pass. There it stands, immovably fixed across an entire waterway, capturing everything, the water being literally strained through it. In one instance, in the Panjab, a whole shoal of mahaseer was observed to be captured by natives fixing a net across a river, and then dragging another down to it, thus occasioning wholesale destruction, and ruining the rod-fishing for the succeeding season. This plan is a very common procedure throughout India, as is also constructing earthen dams across streams, leaving a channel or opening through their center, where a purse-net is fixed, and arrests every descending fish. The largest numbers are taken towards the end of the rainy season, for as the waters fall countless lakes and pools of all sizes are formed on the lowlands in the vicinity of rivers. These, which during the floods were lateral extensions of the stream, now become lakes, having one or more narrow outlets into the river; across each opening nets are stretched, or a weir of grass constructed, and every fish which has wandered up becomes a certain prey to the fishermen.

Fixed engines constructed of non-elastic substances are still more destructive to fish than are such as are made of net, and which are more liable to be rent. Their forms are exceedingly numerous, their sizes infinite, while the interstices, between the substances of which the weirs or traps are composed, appear everywhere much the same, whether examined in the ghats of Canara, the yomas of Pegu, the Himalayas, or on the plains of India or Burma. Still, local influences must occasion some modifications. In hilly districts, as the monsoon floods subside and the impetuosity of the mountain torrents has decreased, they can be erected without being liable to be washed away. Up the hill streams (as I have already observed) some of the most valuable of the carp ascend to breed, and there are now but few which are not weired, and the parent fishes have the greatest difficulty in reaching their spawning grounds. Some, however, surmount the difficulties opposing their ascent; a few deposit their spawn; this completed, the rains are now passing off, the force of the current lessening; but what now occurs to those

fishes which commence descending, trying to regain their low country rivers? I omit in this place how spearing, snatching, or snagging, netting, and angling are carried on, only referring to how fixed engines are employed. Weirs are now erected every few miles, through which the waters of the hill streams are literally strained, while each is fitted with a cruive or fishing trap. The probabilities are that the great majority of the mahaseer which reach the rivers of the plains are the last year's fry that have fortunately escaped destruction during the dry months, and with the first floods have obtained a free highway by the standing weirs being swept away. Wicker traps are likewise constructed across convenient rapids; here few fish can pass without entering, while these are examined twice daily. Or should there be no rapids, such are artificially formed by laying large stones in a V-shape across a stream, while at the apex of this is a trap. Or a mountain stream is conducted down a slope over a large concave basket, so that all descending fish are pitched into it, and speedily suffocated by the rushing water or other falling fish, which act like a succession of blows, preventing their ever rising again.

In addition to the larger weirs and traps, there are minor sorts most extensively employed, especially in the plains; some to capture breeding fish ascending up the smaller watercourse during the rain to deposit their spawn, others to arrest them and their fry attempting to descend the stream as the flood waters recede; and there is not a district, except perhaps in Sind, in which this mode of capture is not carried on. And some officials now speak of the use of these contrivances as communal and prescriptive rights, and their prohibition as an interference with private property.

Movable fishing apparatus.—Movable fishing implements are of two varieties: (1) Those manufactured of cotton, hemp, aloe-fiber, coir, or of some such material; and (2) others made of split bamboo, rattan, reed, grass, or other more or less elastic substances. Large drag-nets, having fair-sized meshes, are used mostly during the dry months, and employed for the purpose of obtaining fish from pools in rivers into which they have retired awaiting the next year's floods. But the movable nets which occasion the most damage are those with small meshes, and principally employed for taking the fry of the fish as they are first moving about; they may be cast-nets with fine meshes, wall-nets dragging up some small watercourses, purse-nets similarly used, and even sheets may be thus employed. In some places several cast-nets are joined together, to stop up all passage of fish along a stream, while others are employed above this obstacle; or several fishermen surround a pool, each armed with a cast-net, and these they throw altogether, giving the fish but little chance of escaping. In Sind the fishermen float down the Indus, in certain suitable localities, upon a gourd or hollow earthen pot, while the net is let down below them; as a hilsa fish, *Clupea ilisha*, ascends up the muddy and rapid stream, it strikes against the dependent net, which is

made to contract like a purse by means of a string that the fisherman holds in his hand.

Irrespective of the modes already detailed as in common use for capturing freshwater fish in India and Burma, there are a number of what may be termed minor plans likewise in force. Sheets have already been remarked upon as employed for taking the fry which have ascended small watercourses, or are found in shallow water, while they may also be used as dip-nets, being sunk in an appropriate place, and raised by strings attached to the four corners, as soon as the fish have been enticed above. Or on the bushes sheets may be placed; here the fry seek shelter from the rays of the sun, and the whole concern is lifted bodily up. A little grain or bread is likewise found useful as a bait. Two pieces of rattan may be employed, crossing one another in the middle, where they are tied together; the ends are then bent downwards in the form of two arches. Here a net is attached, and this the fisherman presses down upon the fish, which are then removed by the hand. In some places they may be so frightened as to permit themselves to be readily taken; thus ropes to which at intervals are attached bones, leaves, stalks of kurbi or jowaree, or pieces of solar (pith), or small bundles of grass, are stretched across a stream; two persons, one at each end, constantly jerk this rope, causing the fish to dart away towards nets that are fixed to entrap them. Snares of the most varied descriptions are almost universally employed; but in some localities angling may be said to be almost unknown, especially in Orissa, or districts where wholesale poaching is preferred as easier and more successful. One method of using hooks is perhaps as cruel as could well be devised. A number are securely fixed, at regular intervals of about 3 inches, to a line for employment in a narrow pass in a hill stream. When used, the rope is sunk from 18 inches to 2 feet below the surface, and held by a man on either bank; others drive the fish towards this armed cord, and as they pass over it the line is jerked for the purpose of hooking the game. In some places dexterity has been arrived at by constant practice, and many fish are thus captured. The desire is to hook the game by its under surface, but, as might be supposed, although in some cases the hooks penetrate sufficiently deep to obtain a secure hold, such is by no means invariably the case. The struggles of the wounded creature frequently are sufficient to allow it to break away, often with a portion of its intestines trailing behind it. If its gill-covers have been injured, respiration may be wholly or partially impeded; crippled, it wanders away to sicken and die in an emaciated state, while, should it be captured before death has stopped its sufferings, it is useless as food, unless to the lower animals. Baited hooks are in some places fastened to lines which are tied to bamboos fixed in the beds of rivers, or to bushes or posts at their edges, and so managed that when a fish is hooked the line runs out. Or a somewhat similar plan is to have a cord stretched across a river, floated by gourds; to

this the short lines which have the baited hooks are attached, but so that they are not long enough to reach the bottom; these are visited every few hours. In some districts night-lines are baited with frogs. Spearing fish by torch-light is extensively practiced in the Punjab and in the Presidency of Bombay, or they may be speared during the day-time in the cold months of the year, when they are not very active. Two persons usually engage in this occupation; the one punts the boat along as noiselessly as possible, while the fisherman stands at the prow silently pointing to the direction to be adopted, and uses his spear when he gets a chance. Shooting fish with guns is carried on in Oudh, and occasionally elsewhere. This is more especially employed for the snake-headed walking-fishes (*Ophiocephalidæ*), which are frequently seen floating on the surface of the water as if asleep. They may be approached very closely, but the game usually sinks when killed, and has to be dived for or otherwise obtained. Cross-bows are also employed for a similar purpose in Malabar. In Mysore—observed the native officials of the Nagar division—fish are taken by nets, traps, hooks, cloths, by the hand, by baskets of different shapes, by damming and draining off the water, by shooting, by striking them with clubs, swords, or choppers, by weirs, and by various descriptions of fixed engines; in short, by poaching practices of every kind, as well as by fishing with rods and lines, and poisoning pools of water. Even fishes' eggs do not escape the general hunt to which the persecuted finny tribes are subjected in these days, the ova being collected and made into cakes, which are considered a delicacy.

Animals destructive to fish.—There are certain vermin in the East which are destructive to fish, some when in the immature, others when in their matured state. Commencing with the crocodiles, two distinct genera have representatives in the waters of India. The true fish-eating crocodile, *Gavialis gangeticus*, with its long and slender snout, attains upwards of 20 feet in length, and is a resident throughout the main courses and affluents of the Indus, Ganges, Brahmapootra, and Mahanadi Rivers, but absent from Burma, and most of those in Bombay and Madras. This species is usually afraid of man, except when he invades the locality where it has deposited its eggs. Their diet appears to consist mainly of fish, turtles, and tortoises. In 1868, I found it was one of the sights of Cuttack to watch these enormous reptiles feeding in the river below the irrigation weir which impedes the upward ascent of breeding fish. The long brown snout of the crocodile would be seen rising to the surface of the water holding a fish crosswise between its jaws; next, the finny prey was flung upwards, when, descending head foremost, it fell conveniently into the captor's comparatively small mouth.

Crocodiles, like predaceous fishes, swallow the finny tribes head first, because, if they are of the spiny-rayed forms, their spines are thus pushed backwards, lie flat, and do not injure the creature which is

swallowing them. Were they taken in tail first, this would erect the spines, and wound every animal which should endeavor to swallow them. Doubtless some forms, while in transit, wriggle themselves round, and get fixed in the gullet of their captors, as the fatherlasher of our coasts.

To show their prolific powers, I may observe that the overseer in charge of the Narrage weir in Orissa came across a brood, and within three hours shot sixty-nine. When at this place I obtained a young one that had become entangled by its teeth in a fishing-net, and asked the fishermen if they ever destroyed them. Astonishment was depicted on their faces, and they protested against the supposition that they had ever been guilty of such a mean action. Their argument was that both classes belonged to the fish-destroying races, therefore, on the principle that hawks do not pick out hawks' eyes, they consider it would be wrong to cause their death. As to the destruction they occasioned, they admitted it, but also observed that they would do as much if they were able. It must not therefore be hoped that fishermen will assist in clearing rivers of these monsters; neither will the native sportsman throw away a single charge of powder and ball on such unremunerative game; which he could not sell and would be unable to eat.

The common crocodile, *Crocodilus palustris* and *C. porosus*, are found in most parts of India and Burma. The reptiles, although often termed man-eaters or snub-nosed crocodiles, assist in depopulating the waters of fish, and it has appeared to me that it is only when they find an insufficiency in the finny supply and carrion that they turn their attention to man and the larger mammals. Every traveler in the East must have seen these logs of wood, as they appear to be, lying for hours at the sides of rivers or on rocks above the surface of the stream, and which sink so noiselessly into the current as almost to make one believe one's eyes had been deceptive, for how could anything so large have so quietly disappeared? In 1868, when at Cuttack, the crocodiles' appetites were not appeased by the fish they obtained, so they commenced consuming human beings, horses, and cows, varying their diet with an occasional sheep or goat. Doubtless, in large rivers, as the Ganges, these reptiles have their redeeming qualities, being the natural scavengers and consumers of carrion. Human beings are now no longer permitted piously to place their dying relatives by the side of the sacred stream, fill their mouths with mud, and leave them to be carried away by the waters or adjacent crocodiles; neither are corpses interred in the current of the holy river. If fish are insufficient, and the crocodiles are not to be destroyed, from whence are these reptiles to obtain their subsistence? The common law of self-preservation will induce them to feed on the cattle of the neighboring country or on such human beings as unwarily approach too near to the waters in which they reside. This is no fancy sketch, but I will adduce merely two instances that came under my notice in 1868. At Cullara exists a hole or pool in the Nuna River to

which these monsters resort during the dry season, and a short time prior to my visit they had suceeded in carying off five adult human beings; while near the Baropa weir two women and one horse were taken by crocodiles in a single month.

Otters are likewise very destructive, especially in the hilly districts, and when they have exhausted the fish they turn their attention to the frogs. In fact, the large frogs, *Rana tigrina*, are evidently considered great delicacies by these animals, for when kept domesticated they even seem to prefer them to fish. In some rivers, as the Ganges and Indus, the porpoise, *Platanista*, is a great fish consumer.

When mentioning animals which compete with man in destroying fishes, there are some families that must not be omitted, although I propose only casually to allude to them. Birds which eat fish are exceedingly numerous, not only in the true swimming and wading forms, but even the Indian pewit may be observed during the dry months, taking its share of the smaller examples of the finny tribe which are more or less exposed to view in the drying-up pools. Snakes luxuriate in irrigation canals and revel in luxury at the bases of the larger weirs. In that across the Coleroon, when the water was low, I was plainly able to see these reptiles lying in wait for the fishes attempting to ascend. I should suppose I never saw less than twenty any evening I examined this weir on its down-stream race. Tortoises and turtles are fish consumers; while most fishes prey upon their weaker neighbors or their eggs. Near Ganjam, a native official informed me that he had ventured out one night to see how murrul, the walking-fishes, were captured. The fisherman was provided with a long flexible bamboo as a rod, and as a bait used a live frog. Hardly had the frog splashed into the water when a moderate-sized murrul seized and swallowed it. Desirous of observing what would next occur, the fish was left on the hook, as a bait for anything else. Before long a large water-snake was seen swimming towards it, and soon had the fish inclosed in its capacious jaws, and in this fashion all three were pulled together out of the water. Frogs appear to relish fish-eggs, and to be by no means adverse to devouring the fry occasionally.

Legislative protection of fish.—Considerable discussion arose upon this subject in India, some high officials suggesting that a falling-off in the quantity of freshwater fish is no reason for legislative interference, unless it could be demonstrated that a danger of annihilation existed. The viceroy summed up the question in the following suggestive sentences: "Is the present plan of non-interference likely to insure to future generations the fullest possible supply of this food staple? Is it even such as to insure their inheriting a supply equal to that which now exists. The governor-general in council apprehends that both these questions must be answered in the negative, and not only is there no prospect, as matters now stand, or of an increased supply hereafter, but

that, owing to the absence of precautionary measures and reasonable restrictions, the existing supply is diminishing."

Before concluding this portion of my paper, I must refer to an experiment which has been made in India for the purpose of protecting fisheries. If no destructive waste was existing prior to the commencement of protective measures, no augmentation of the fish would have become apparent; if, however, very beneficial results have ensued, there does not appear any reason why such should not be extended elsewhere. In South Canara, Mr. H. S. Thomas observed that it may be doubted whether the poisoning of rivers or the wholesale destruction of fry is most injurious to fisheries; while the effect of prohibiting the finer and closely-woven bamboo cruives has been that the most ignorant, and therefore the most obstinate, opponents have been convinced by the testimony of their own senses, and have exclaimed, to use their own words, "Truly the river is everywhere bubbling with fry;" and, what is still more to the point, their practice has not belied their words, for they have taken to fishing on grounds that were before considered profitless. Two years' discouragement of poisoning, and one year's discouragement of fine cruives, have worked such a change that it has been demonstrated, beyond cavil even of the ignorant and of the most interestedly opposing, that marked advantage can be reaped from the adoption of these two simple measures alone.

What measures have been instituted in order to mitigate the condition of the fisheries I have been unable to ascertain. Sir Richard Temple says, "No result worthy of note." An act (VII of 1875), however, has been passed for Burma, for the protection of the fisheries; while Mr. Buckland, member of the revenue board in Calcutta, remarked (November, 1879) that the following figures show the progress which is being gradually made at Goalunda, at the confluence of the Ganges, and Brahmapootra, where hilsa fish abound: Fish cured 1875, 1,362 maunds; 1876, 4,835; 1877, 10,800; 1878,* 14,000. He concludes that "there is, therefore, some reason to hope that Dr. Day's proposal may bring some good fruit after awhile."

3.—Consumers of fish.

Before passing on to the sea-fisheries, I propose considering what proportion of the people of India and Burma use fish as food, or rather can do so without infringing caste prejudices.

In the Panjab, comparatively few of the inhabitants are prohibited by their religion from consuming fish, but there are many Hindus who reject it, as well as the rural population of some districts. But of those residing in towns, and in hilly ranges, it appears that, if the Brahmans are excepted, the consumption of fish is limited only by the

* This shows an increase of 1,043,215 pounds of fish in a year in one locality, where in the first of the four years nearly 112,073 pounds were prepared.

paucity of the supply and the cost of the article. In Sind fish is generally eaten by the population of the province, whether Mussulman or Hindu, except the Brahmans. In the northwest provinces, containing about 28,000,000 of population, out of twenty returns received from native officials seventeen give more than half of the people as not forbidden by religious scruples to eat fish. In Oudh, the majority of the people appear to eat fish, but the supply is unequal to the demand. In the Bombay Presidency, the majority of the inhabitants of the inland districts are consumers of fish when they can procure it. In Haidarabad, Mysore, and Coorg, more than half the population are fish consumers; in South Canara, 89 per cent; in Madras, the majority, the exceptions being Brahmans, goldsmiths, high-caste Sudras, the followers of Siva, Jains, &c. In Orissa, more than half the people; in Bengal proper, from 90 to 95 per cent; in Assam and Chittagong, almost the entire population; and in Burma, in the form of *nga-pee* its use is universal.

As Buddhists, the Burmese profess a religious horror at the taking of the lives of lower animals, but being immoderately fond of fish diet, they console their consciences (while indulging in it) with the idea that the deaths of those animals used by them as food must be laid to the account of the fishermen, and cannot in any way be attributed to the consumer's fault. The walls of their temples have pictures of the terrible tortures the fishermen will have to endure in a future state of existence. In some of these interesting representations are large fires being stirred up by devils, while other evil spirits are dragging more fishermen in nets towards the burning, fiery furnace, helping on some by striking fishspears into them from behind, and hauling them forward by hooks and lines towards the place of punishment.

But, it may be asked, are these ponghees' (priests') practices in accord with their teachings? By no means, as the following example will show. At Yahdown, on the banks of a branch of the Irawadi, a fisherman (Een Thoogye) built a *Kyoung*, or monastery, as his great hope was to be termed a *Kyoung taga*, or founder of a monastery, a highly prized title amongst the Burmese. Ponghees came, and ponghees went away, but they did not care to remain and partake for any lengthened period of the hospitalities of their host and disciple. At last one old priest appeared, who seemed to consider the quarters as desirable. To him, in great trepidation, the owner put the following question, "Why, my father, do not the ponghees approve of my monastery, for none but yourself have remained over the going down of two suns?" "Because, my son," replied the holy man, "do you not break the law by depriving fish of life?" "True," he answered, "but were I not to do so, how could I supply your table with fish, or how could I live were I to give up my employment?" The only reply he could obtain was, "Better to fast while keeping the law, than to feast while breaking it."

With sorrow the disciple took the priest at his word, and for three days refrained from fishing, giving his preceptor merely vegetables for his diet. On the fourth morning, when the same fare appeared, the ponghee observed, "My son, when you fish the river, does your net extend all across, permitting no fish to escape; or is a portion of the river free for those which select to pass to one side?" "Not all across, but only one-third of the way," he answered. "Well then, my son," said the priest, "I have been seriously considering the subject, and have arrived at the conclusion that, if you leave room for the fish to ascend or descend the stream, and they will not avail themselves of it, but rush headlong into the net, the fault is theirs and not yours. Even Guadama blessed the hunter who met him when he was hungry and supplied him with venison. This was accounted as a meritorious act, although he must have killed a deer to obtain it. So go, my son, and procure me some fish, for I am hungry." From that day the priest consumed his fish in quietness, and refrained from inquiring from whence it had been procured.

Supplies to the markets.—Investigating how the local markets were supplied with fish up to 1873, the replies from native officials gave the following results. In the Panjab one in ten markets was sufficiently supplied; in the northwest provinces, one in three; in Oudh, one in four. In Bombay the amount was stated to be insufficient in all, and the same reports came from Haidarabad, Mysore, and Coorg. In Madras, near the sea, the quantity of fish was sufficient, but only in one in ten of the inland markets. In short, merely one-tenth of the bazars were reported as fully supplied with fish; and of this tenth one-fifth obtained them from the sea-coast.

B.—SEA FISHERIES.

Fisheries, to a more or less extent, exist in the Indian Ocean, as well as up the mouths of the larger rivers, in backwaters and estuaries, while parallel to certain places, especially along the coasts of the Madras Presidency, vast mud banks are present in the sea, having such a thin consistency that many kinds of fish are able to obtain abundance of food there, as well as a suitable locality in which to deposit their ova. The most casual observer cannot fail to perceive how numerous are the varieties and vast the number of the finny tribes in the seas of India, but from some cause—whether due to the legislative enactments and local obstructions, or to native apathy and impecuniosity—the harvest has, up to within the last two years, been comparatively untouched; an enormous amount of food still remains uncaptured, while famines are devastating the contiguous shores.

Want of space must be my excuse for not entering upon the various forms of fishes which populate the seas of India, and I pass on to their economic uses, for their well-stocked fisheries should be exceedingly valuable, as affording an inexhaustible supply of animal food, not only

to persons residing in their vicinity, but also inland, should means exist to transport such in either a fresh or salted condition. The extent of the seaboard of India and Burma has been estimated at 4,611 miles; the fisheries are uninfluenced by recurring droughts, and ought to afford an inexhaustible harvest of food along the entire coast of the country.

Irrespective of mere food, maritime fisheries ought to be serviceable directly, as producing isinglass, fish-oils, and manure; or indirectly, as necessitating materials for the building of vessels, the manufacture of nets, hooks, and lines, the carriage of produce, &c. The modes adopted for utilizing fish as food along the sea-coasts of India and Burma may be considered under (1) fresh fish, how far they can be conveyed inland; (2) dried fish and its varieties; (3) cured or salted fish, and how prepared.

Transporting fresh fish inland.—How far can fresh fish be conveyed inland? In examining this question, if the employment of ice or salt is omitted, the distance sea-fish can be carried inland, while fresh, depends upon several circumstances. The season may curtail this, as during the hot months putrefaction commences very rapidly; while some forms, especially the immature, the herring, and the siluroids, decompose more quickly than others; and the same result follows close packing, or want of protection from the full force of the sun's rays. Usually fish are not landed until after sunrise, while those brought on shore of an evening are generally kept where they are until the next morning, coolies being averse to traveling after dark. On the other hand, facilities of carriage may exist, as railways, water communications passing inland, or arrangements made for this purpose. As a general rule, inland places having no special facilities for carriage do not receive uncured sea-fish in a wholesome condition upwards of 10 miles from the beach where they were landed. Should, however, the fish be first opened and cleaned, some salt rubbed in, and care taken in their conveyance (as warding off the sun's rays), they may be safely carried considerably further. But salt being very expensive, it is seldom employed for this purpose, or else a very slight amount is used, and putrefaction has often set in prior to the fish being disposed of for human food.

Varieties of dried fish.—What varieties of dried fish exist in India? Due to reasons which will be given subsequently, it has become the custom along the shores of British India, which are subject to the salt tax to its full extent, simply to dry fish in the sun. This can be done with smaller and thinner forms, as *Ambassis*, *Equula*, the Bombay duck (*Harpodon nehereus*), many of the herring and small varieties of immature forms, but not with the larger fish; however, even from these last, slices may be cut and sun-dried. In some localities small fish are first buried in the sea-sand, in order to obtain a little saline substance, and subsequently sun-dried. In damp weather such articles rapidly decompose, while in the hot months they are attacked by innumerable insects,

Salted fish.—Lastly, how are fish salted? The processes employed are chiefly divisible into the two following: (1) Those cured with monopoly salt, or salt which has paid the Government tax; and (2) those prepared with salt-earth, or spontaneous and untaxed salt. It must be here remarked that I have very little information as to what changes have been effected during the last five years, but I believe a slight (5 or 10 per cent) import duty has been collected on salt fish landed from foreign ports, while the salt tax in Sind, Bombay, and Madras has been increased to a very considerable extent. I propose first referring to salt and its cost; for wherever the fisherman or fish curer can obtain this condiment at a cheap rate, there marine fisheries flourish; where it is dear, his occupation is destroyed, except for the purpose of supplying daily wants and a little surplus for salting or sun-drying. This will be most easily explained by referring to the different districts in detail.

Exportation of salted and dried fish.—The amount of salted and dried fish exported by sea from Indian ports was as follows (the value is given in pounds, computing 1 rupee at 2 shillings*):—

Five years ending.	From Sind.	From South Canara.	From Malabar.	From Coromandel coast.
1857–'58	£8, 472	No returns..	No returns..	No returns.
1862–'63	13, 064	No returns..	£26, 272	No returns.
1867–'68	18, 725	£6, 969	48, 207	£1, 753
1872–'73	22, 944	14, 921	90, 849	4, 513

The duty on salt in Sind was 2*s.* a maund of $82\frac{2}{7}$ pounds avoirdupois, sometimes less, during the entire period comprised in the above table.

Government tax on salt.—The first great increase in salting fish occurred in 1860–'61, in which year the duty was raised in Bombay from 2*s.* to 2*s.* 6*d.* a maund. The next spurt of this trade, in Sind, was in 1864–'65, when the salt-duty in Bombay was again raised from 2*s.* 6*d.* to 3*s.* a maund. Possibly the importations into that Presidency from Sind would subsequently have been more, but the Government decided, in 1867, to admit all salt fish from foreign ports, where no salt-duty exists, into British India free of duty, to the immense advantage of the Portuguese settlements and the Meckran coast, but completing the ruin of Indo-British fishermen and fish-curers, unless they were advantageously located.

In olden times salt was allowed duty-free in British territory, for salting fish; but this enactment was repealed (year not ascertained) because the excise officers considered that it assisted smuggling.

The following table, being returns from different districts on the west or Malabar coast of Madras, shows the annual sales of Government or

*In the United States the shilling is worth 24.3 cents, and the rupee is worth 43.6 cents.

monopoly salt, along with the value of the salted and dried fish, which were exported by sea:

Year.	South Canara.		Canore.		Tellicheri.		Travancore and Cochin.	
	Fish.	Salt sold.	Fish.	Salt sold.	Fish.	Salt sold.	Fish.	Salt sold.
		Maunds.		*Maunds.*		*Maunds.*		*Maunds.*
1863–1864	£1, 057	191, 002	£96	11, 653	£1, 459	72, 505	£5, 416	728, 268
1864–1865	3, 036	168, 279	219	7, 932	1, 504	57, 516	6, 052	643, 897
1865–1866	875	184, 174	11	9, 856	194	62, 135	7, 061	672, 379
1866–1867	1, 124	151, 113	12	9, 728	1, 825	57, 381	7, 337	497, 988
1867–1868	875	174, 629	303	8, 721	2, 011	56, 502	7, 803	558, 766
1868–1869	114	176, 465	520	9, 045	4, 319	63, 340	7, 130	573, 639
1869–1870	2, 053	147, 173	4, 340	8, 807	5, 839	72, 616	6, 096	574, 119
1870–1871	2, 927	136, 967	1, 470	7, 932	5, 309	57, 624	5, 833	593, 389
1871–1872	2, 845	177, 482	695	12, 008	5, 340	88, 674	6, 987	577, 268
1872–1873	5, 980	135, 839	951	6, 985	8, 429	77, 332	....	....

The table shows that the amount of annual exports of salt and dried fish in Western India had very little, if any, connection with the quantity of monopoly salt which was disposed of.

Curing fish with salt earth.—In the native state of Cochin, the sale of salt in ten years, ending 1872–'73, owing to augmented duty, was reduced by two-thirds, while it was during this very period that the great increase in the amount of exported salt fish began. In the contiguous British district of Chowghaut, although in the year 1872 £1,067 8*s.* worth of salt fish were exported, only £46 worth of monopoly salt was disposed of. The cause of this is susceptible of an easy explanation. Owing to some flaw in the land or revenue laws, or else due to an immemorial custom, it was ruled that the people might collect salt earth in order to cure fish for their own consumption; while, there being no law restricting their disposing of any surplus they possessed, a large trade in selling such sprang up. Consequently, fish-curing did not require a large capital to commence with. This induced an increased demand for fish; the fishermen's trade became remunerative, and an immense amount of animal food found its way into the market which would otherwise have been lost. That this is the correct explanation is shown by examining the state of the fisheries on the eastern coast of the Madras Presidency at the same period. There the right to gather salt earth is not recognized, but, observed one official, the practice of salting fish must be increasing, considering that the price of the fish, which formerly cost 2*s.*, has been reduced to 1*s.* 3*d.* or 1*s.* 6*d.* This reduced value of the fish was doubtless due, not to the increased prosperity of the fishermen, who were evidently in a miserably poor state, but that the absence of salt wherewith to cure fish had diminished the demand for the article, and fishermen had to be content with a lessened price. The Madras revenue board * (May 14, 1873), observed that the fishermen numbered through-

* One of the members of the revenue board at Madras, writing to me on November 8, 1882, observed, "The industry (of salting fish) is really commencing at last; 400 tons more were salted this year than last, and 80 more yards for curing are to be opened in a month or two.

out the Madras Presidency 394,735 persons; that the answers elicited by the questions put by Dr. Day have directed the attention of the board to the subject of the influence of the salt duties on the trade of fish-curing, and they see reason to think that a great practical hardship exists, which they would advocate immediate endeavors to alleviate. A small amount of fish is prepared with monopoly salt in Madras,† especially for local consumption and export to Ceylon; but the amount of this condiment employed by fish-curers cannot be great, as it makes no perceptible figure in the amount of salt disposed of. In Bengal, the excised salt appears never to be employed for fish-curing, and the fisheries are in a neglected state; or, as observed by the collector of Balasore, "Fish sold in the markets are so stale that no European would touch them, and most of them are putrid. The people in this district do not salt their fish; they dry them in the sun, and eat them when they are putrid. They like them in this way, and there is no reason why this should be interfered with." Salt was then (1870) subject to a duty of 10*s.* for 82 pounds weight. Farther to the eastward, in Burma, the salt duty was 1*s.* fo the same quantity, sun-dried fish a rarity, the fisherman's trade flourishing, while salt fish, or crustaceans in the form of *nga-pee*, invariably formed part of every meal among the indigenous population.

Proportion of salt to fish.—It will be necessary to remark upon the amount of salt which must be employed in order to prepare properly a given quantity of fish. In Sind 20 pounds of monopoly salt are added to $82\frac{2}{7}$ pounds of fish; on the western coast of Madras, as Tellicheri, 28 pounds of salt are used to $82\frac{2}{7}$ pounds of small fish, as mackerel, herring, &c. It appears that, for the purposes of the trade, one part of monopoly salt is necessary to about three parts of fish. However, at Gwadur, in Beloochistan, where this condiment is very cheap, a larger proportion of it was used than in either Sind or in India. Fish cured with salt earth, or spontaneous but untaxed salt, require a much larger amount of this antiseptic than they do of monopoly salt, or nearly three (upwards of $2\frac{1}{2}$) parts of salt earth to one part of fish.

Effect of the salt-tax.—The cost of salt, it will be perceived, must have a bearing upon the state of the fisheries; where it is cheapest (other things being equal) the fisherman's trade will be most developed. Along the coasts of Beloochistan, where there was no salt-tax (1873) large communities were supported entirely by fisheries, their captures being cured and exported for the Indian or Chinese markets. The same remark applied to the Portuguese settlements of Goa, Daumaun, and Din, the salt used there costing about 3*d.* per $82\frac{2}{7}$ pounds weight, whereas in the contiguous British territory it stood at the salt-pans at about 4*s.* Hence the foreign fishermen were able to use this condiment

†The salt-tax in Madras in 1859 was 2*s.* per maund, but has since been raised as follows: 1859-'60, 2*s.* 9*d.*; 1860-'61, 3*s.*; 1864-'65, 3*s.* $4\frac{1}{4}$*d.*; 1869-'70, 4*s.*; 1875, 6*s.*; now 4*s.*

freely, and the cured articles were preserved in a superior manner, more wholesome to the consumer, and able to be carried farther inland. In short, fisheries thrived along the Beloochistan coast and the Portuguese settlements, due to the excise on salt being not excessive or entirely absent. In the Bombay Presidency the fisherman's market became restricted to the sales for immediate consumption or else for sun-drying, or, as the collector of Tanna observed, "Whether fish is dried as above, in preference to its being salted, is a question I have been unable to ascertain. It is very probable that it has been resorted to in the place of curing by salt consequently on the excise duty levied on salt." Wherever salt earth could be obtained free of duty along the western coast of Madras there the fisheries thrive, the fish-curer requiring a large supply of fish. Along the east coast of Madras the collection of salt earth was more or less prohibited, and the fisherman's trade, except near large towns, is not very flourishing. But in Bengal the fisheries are, or were, worst off, sun-drying being the only curing which fish obtained. Lastly, in Burma, where salt is cheap, the fisheries were thriving. Before concluding this portion of my subject, I would observe that it is not to be supposed that fish cured with salt earth are of the best quality; on the contrary, it imparts a bitter and unpleasant flavor, and is believed to engender disease. But the poor cannot be particular respecting the taste or smell of their food; the cost is the important question. Salt earth costs about $\frac{1}{2}d.$ a basket of 144 pounds weight, depending upon its quality; but, as I have observed, it takes three times the amount that it is necessary to employ if excised salt is used. But $82\frac{2}{7}$ pounds of monopoly salt was taxed $3s. 7\frac{1}{2} d.$ at this time; now $4s.$; whereas 246 pounds of salt earth cost from three-fourths penny to $1d.$, and this is the reason of the latter being preferred by fish-curers for the purpose of preparing fish for the trade; for if monopoly salt at its present rate was used, the article, at least to the general public, would be simply unpurchasable. Fish are plentiful in the sea. The reason why the harvest remains ungathered is not due to the apathy of the fisherman or the unwillingness of the general public to be consumers of fish, but solely a result of the heavy cost of salt, and that a consequence upon the Indian salt-tax.

1.—CONDITION OF FISHERMEN.

Having briefly enumerated the fish which stock the seas of India, and how the fisherman's and fish-curer's occupations are injured by the incidence of a heavy salt-tax, I pass on to the fishermen and their condition, as it was a few years since. Doubtless, should no sufficient market exist for the produce of their industry, some of these people will leave fishing and engage in other pursuits; while those who remain endeavoring to make a livelihood, as did their forefathers, will seek the cheapest way and easiest method by which such may be accomplished. A very little acquaintance with the habits of fish suffices to teach the

fishermen that the smallest kinds are taken with the greatest ease; as preferring the vicinity of the shore, and seeking their food in shallow waters, they are more readily captured in weirs, or with fixed engines and traps, than are the larger, more predaceous, and strictly deep-sea forms. But by disturbing the shore, and destroying or driving away the small fish and crustacea, the food is being diminished which previously decoyed the larger and more predaceous forms in, thus scaring away what would otherwise be the natural supply; and then it is erroneously asserted that the amount of fish has decreased. The fisherman's business is to supply personal requirements and family wants; consequently, if he obtains as much of the finny tribes as he can find a market for or otherwise employ, no injury is inflicted by such a proceeding; because, so long as salt is not available (owing to its price) for the purpose of curing the surplus which may have been captured, meeting the small local demand for fresh fish is all that is really requisite.

The deep-sea fishermen, or rather those who ply their occupation outside the shallow waters of the littoral zone, as a rule do so by means of nets, or with hooks and lines. Deep-sea netting is not carried on to any great extent, partly because of the insufficiency of a good market to render such remunerative, and likewise owing to the expense which would be necessary in obtaining the requisite nets, and the cost of building seaworthy boats. Fishermen are not to be ranked among the moneyed classes, and so they have to borrow money, at exorbitant rates of interest, wherewith to supply themselves with the requisites for their work. As an instance, in Sind a net suitable for sea-fishing would involve the outlay of £40 or £50 [about $225], while it does not usually last more than a year. A boat costs about £100 [$485], and ought to be serviceable for several successive seasons. The money having been borrowed, the fisherman who is the borrower disposes of the whole of his capture at half the market rates to the person who has supplied him with the money. Still this leaves a surplus, due to the existence of a good market for the fish-curer's trade.

Castes among fishermen.—The sea fishermen in most parts of the coasts of India assert that in olden times they were divided into two distinct classes: (1) Those who captured fish in the deep sea, or beyond their own depth; and (2) others who fished from the shore and in the backwaters and creeks. Now, owing to the depressed state of the fishing trade, the deep-sea fishermen (except where salt is cheap or a good market exists) have taken to the less expensive occupation of plying their work inshore. In several parts of India, more especially in the Madras Presidency, they have customs of a patriarchal nature, but which are more strictly observed on the Coromandel than on the western coast. In Sind there are four divisions of the fisherman caste, each being under its own chief, who is hereditary, and his business is to settle caste disputes and other trifling matters, also to conduct the religious ceremonies con-

nected with marriages and deaths. In the Bombay and Madras Presidencies, headmen to the fishing castes likewise exist; in some localities they are hereditary, in others elective; or should there be no headmen, matters are laid before certain wealthy individuals of their own caste, whose decision is final. In places where the fishermen are native Christians, the priest appears to be appealed to in order to settle disputes.

In olden times the fishing castes held a much more important standing than they at present possess. Commanded by their own chiefs, they were ready to engage in military expeditions. The Samorin, in 1513, sent a deputation to Portugal, and his ambassador, who turned Christian, was knighted under the name of "John of the Cross," by John III. On his return to India he was banished from the Samorin's court, as a renegade from the faith of his fathers. In 1532 he joined the fishermen, and appears to have been installed as their chief, as he headed a deputation of eighty-five of them to Cochin, soliciting the assistance of the Portuguese against the Mohammedans. The whole of the embassy are said to have become converts to the truths of Christianity, so a Portuguese fleet was sent to their relief, and 20,000 are reputed to have immediately consented to be baptized. Ten years subsequently, Xavier instituted a church for these people.

It appears probable that the present organization of the fishing classses is the remains of some ancient system, for on no other supposition can the existence of individuals holding an extensive sway be accounted for. The village or patriarchal system of an elective headman to such of his caste as inhabit each street and hamlet, is what is seen elsewhere among laborers; so likewise is the hereditary headman over several villages. But among the fishermen there exist priestly chiefs, two of whom are to be found on the eastern coast, one being at Madras and the other at Cuddalore, the territory of the former stretching up the Coromandel coast, while that of the latter reaches towards Cape Comorin. A third is found in South Canara, where he exercises spiritual control over a large district, and it is by no means improbable that others may exist. These chiefs, whose offices are hereditary, claim and receive fees and fines from those of their caste living within their jurisdiction, and they are the final referees in all cases of caste or family disputes.

The next grade is also hereditary. These mere petty chiefs or headmen hold sway each over only a few villages; their duties are the same, and some of their fees seem to have to be transmitted to their superior. On one of these headmen dying without heirs, a new one is elected by the people of the caste. Lastly, the fishermen have the elective headman, who is chosen by the residents of a single hamlet; his duties are to decide disputes, to be present at marriages and religious ceremonies, often to fix the work, and assist in certain Government duties; his emoluments appear to be very trifling.

Financial methods and poverty of fishermen.—Passing on to the condition of the fishermen (as it was a few years since) in Sind, they have to

pay a tax of 10*s.* a ton yearly on their fishing-boats, while I have already alluded to the rate at which they borrow money for the purpose of procuring boats and nets. Here these people are well off. At Gujerat, in Bombay, the fishermen are poor, and the precarious living they make often induces them to accept service as sailors, laborers, or anything that insures them a steady competence. Although following out the condition of the fishermen in various districts must have rather a sameness, it will be necessary to do so in order to see clearly whether these people are really in a prosperous or in a poverty-stricken condition; whether, in short, it is the case that they are in the utmost misery, not due to their own laziness, but as a result of British legislation imposing prohibitory duties on salt, which is even now being made heavier and heavier, regardless of the injury to these people, and the enormous loss of food to the inhabitants at large. In the Junjura district the fishermen supply themselves with boats and nets; six or ten club together to obtain a boat and net, dividing the produce; here they have decreased in numbers. At Broach they are also said to have diminished. The same report comes from Kaira. In Rutnagiri the practice of salting fish has decreased during the last fifteen years in consequence of the increase in the price of salt, but the fisherman are said to have increased. If, however, the practice of curing fish has decreased while the number of fishermen has augmented, such must be due to a greater demand for fresh fish, or else the fishermen, from increased numbers, must be worse off than they previously were. However, the official from Canara gave a similar reply. The commissioner observed that at present no larger number of men are engaged on fisheries than are required to provide sufficient for local consumption. The practice of curing fish has largely diminished, owing partly to the falling off in the amount usually captured, and also to the duty on salt in British territory.

In the Madras Presidency, we are informed that, in the Tinnevelli collectorate, the fishermen, as a rule, are a very miserable lot of people, and exceedingly poor. The way in which they work is by a system of advances made by traders, a few of whom reside in each fishing village, and supply all the requisites for fishing, as well as the boats, taking one-third of the captures as their share. In the Nellore district, although no one claims exclusive rights to the sea fisheries, the inhabitants of the different villages are exceedingly tenacious in order to prevent fishermen from other localities plying their occupation within what they believe to be their limits. In the South Canara district, where the use of spontaneous salt is, or rather was, not prohibited, the number of sea fishermen is stated to have increased of late years. This augmentation has been computed as high as 15 per cent. The same symptom of prosperity was reported all down the Malabar coast. At Ponani there is an annual increase in the number of fishermen. At Cananore the owners of boats and nets supply them to these people, as well as advance certain sums of money. The money-lenders sell the

captures, half the proceeds going to either party; if, however, the take is insignificant, the boat and net owners surrender their share to the fishermen. A like plan obtains at Tellicheri, where the fishermen have framed rules for their own guidance, one of which is the right of the first discoverer, among a lot fishing together, to a school of fish; he is allowed to capture them without hindrance from the others, even though at the time when the fish were discovered he was not prepared to launch his net. Passing out of the districts where the free collection of salt earth is permitted, another change for the worse in the condition of the fisherman is reported. In Madura it is said that, on the whole, the sea fishermen have increased, but that the aboriginal fishing castes have decreased, owing to emigration or to their becoming sailors. At Ootipadaram the native official estimates the daily earnings at three pence, taking all the year round, and excluding costs, and at Munjery at from three halfpence to nine pence, while at Tenkarei their earnings are computed at from three pence to one shilling a day. In the Tanjore collectorate they are reported to have decreased in some places, but remained stationary in one locality. A little better report comes from Madras, but there the fishermen are also employed as boatmen, which is very profitable, while the vicinity of large stations affords a sale for fresh fish. Without tracing out the condition of these people in each district on the coast, it will be sufficient to say that they are poor and miserable, but not so badly off as in the Bengal maritime districts, where they appear to be quite poverty-struck. Passing on to Burma, with its cheap salt, we find the sea fishermen well off.

If we pass in review the reports from all the sea districts, we find the fishermen well of in Sind, while, unless in the vicinity of large towns, they are miserably off in the Bombay Presidency. Along the western coast of Madras, with its untaxed salt earth, these people prosper; but once round Cape Comorin, where the collection of spontaneous salt becomes a penal offense, they become, as observes the collector of Tinnevelli, a very miserable lot of people, and such is the same account all up the Coromandel coast, except where there are large towns. With poverty we find them reported to be decreasing in numbers, due to cholera or other diseases, emigration, or accepting service as lascars in coasting vessels. These are a people who in olden times were among the most prosperous of the inhabitants along the coasts of India; who, when the Portuguese first landed, were able to bring large armies into the field; whose occupation is now thought unworthy of the care of the legislature, except when it seems possible to impose new taxes on their industry, in the shape of an augmented salt-duty—as a European official remarked, that sympathy ought not to be wasted on fishermen, for they are an independent, careless, and drunken set of men. This gentleman, trained up in the latest school of political economy, I believe, merely placed on record what are the feelings of many who are acquainted with the state of this trade, for by careless and independent

he probably meant idle, which idleness is due, first, as I have already explained, to the incidence of the salt-tax; and, secondly, that when salt is unobtainable, did they exert themselves, the market would become overstocked.

Résumé.—Such is a brief outline of the fisheries of India, the part they subserve in providing food for the people, and the hindrances under which they suffer. Excellent and painstaking as are our Indian officials, there are but few among them who have time to interest themselves respecting the complex question of fisheries, while the fishermen are among the most patient of the races of India, and the least likely to bring their grievances to notice. It thus comes to pass that the philanthropist, with mistaken zeal, throws open freshwater fisheries to the people, causing their depletion or almost ruin.

The legislator believes that permitting the fishermen to collect salt earth, or obtain salt duty free, will only be assisting the smuggler, and allows him no exemption. The financier, requiring money, sees in salt-taxes the best means of obtaining it, and forgets, or perhaps never investigates into, how such is detrimental to the health of the inhabitants, and ruinous to the fisheries; while the high official who permits matters to drift as every chance wind blows is merely following, in respect to fisheries, the example given in this country, where they are by turns cared for or disregarded, and every interest save those of the finny tribes has its advocates and upholders of its vested rights.

XIV.—EEL-FISHING WITH SO-CALLED "HOMMOR" (A SPECIES OF FISH-POT) ON THE BALTIC COAST OF SWEDEN AND IN THE SOUND.*

By Rudolph Lundberg.

The eel is certainly found along the entire coast of Sweden, and everywhere forms an object of fisheries, although their extent, and consequent economical value, vary greatly on different portions of the coast. On our coasts we must distinguish between two kinds of eel-fisheries—those which aim at the eels which are found on our coasts all the year round, and those whose object is the migratory eel, which are only carried on during the latter part of summer and during autumn, with a special apparatus, constructed for catching migratory eels, the so-called "hommor."†

These last-mentioned fisheries are, beyond a question, the largest and most important, and both for this reason and for the sake of the conclusions relative to the mode of life of the eel, which may be drawn from the data gathered so far, as well as the hints for further investigations which they furnish, I have thought that a brief review of this fishery would be of interest.

Before going any further, I deem it necessary to say a few words with regard to the character of the apparatus in question, or the so-called "hommor," and the manner of carrying on this fishery.

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*"*Om ålfisket med s. k. hommor vid svenska Östersjökusten samt Öresund.*" Stockholm, 1881. Translated from the Swedish by Herman Jacobson.

†The fishermen make a distinction between the stationary and the migratory eel. Whether these different eels must be considered as separate species or only as various stages of age and sex, is a question which I will not attempt to answer, as I have not had an opportunity to investigate the subject. Kröyer considers the migratory eel as a separate species (*Anguilla migratoria*), and even Nilsson gives it a special name (*Muræna acutirostris*). Ekström, Yarrel, and some of the older zoologists distinguish several species of eels. More recent naturalists, like Siebold, think that there is only one species of the European eel, and even Günther thinks that these differences, principally relating to a difference in the shape of the nose, do not entitle us to assume different species of eels. Günther, however, makes a distinction, based on a difference in the position of the fins, between two European species of eels, viz, the *Anguilla vulgaris* and the *Anguilla latirostris*. The varieties of the eel distinguished by our fishermen are the same as those given in Nilsson's "Fauna"; but the fishermen pay less attention to the shape of the nose than to the color, which with the grass-eel or coast eel is a yellowish green, and with the migratory eel white or whitish gray, and to the size and flavor. The grass-eel is smaller, has softer meat, and is leaner than the migratory eel.

The "homma" must be considered as a large fish-pot, with one or, generally, two arms on the sides, one being considerably shorter than the other. They are always set, beginning at the coast, either one by itself or several in a row, the longer arm of each succeeding "homma" extending alongside or back of the one in front of it.

THE EXTENT OF THE FISHERY.

I now proceed to give an idea of the extent of this fishery. The northernmost point, as far as I know, where eel-fisheries with "hommor" are carried on, is the neighborhood of Grisslehamn, and the coast south of that place towards Arholma and Tjockö, where this fishery is said to have commenced about the year 1840. We do not meet with any "hommor" eel-fisheries till we reach the southern part of the coast near Stockholm, from Elfsnabben to Landsort. On the coast of Södermanland and the northern part of the coast of Östergötland no "hommor" eel-fisheries are carried on. These fisheries, however, commence again in the southern part of the coast of Östergötland, beginning in the neighborhood of Arkö, and are carried on along the entire coast of the Kalmar district as far south as the city of Kalmar. I am not prepared to say at the present time how far south of Kalmar, towards the boundary of Blekinge, these fisheries extend. On the coast of Blekinge these fisheries are carried on from Christianopel, and farther south towards the districts of Thorhamn and Sturkö. From the latter place they decline, and are only carried on along the outer coast-line as far south as Carlshamn and the inner part of the Hanö Bay, where from time immemorial very considerable eel-fisheries have been carried on, along the coast of the Mjellby district, from Nogersund and Hörvik as far as Pukavik. The migratory eel, however, do not visit the southern part of Listerland, but are found in large numbers on the eastern coast of Scania, from Ahus and Yngsjö, as far as Stenshufvud, where eel-fisheries are carried on along the entire coast, and farther south, past Sandhammaren and as far as Kaseberga. Between the last-mentioned place and Abbekås the migratory eel does not come near the coast. Near Abbekås, however, there are considerable "hommor" eel-fisheries, but after that we do not find any till west of Trelleborg, principally in the Kämpinge Bay, and as far as Cape Falsterbo. On the other side of this cape, and towards the sound, no "hommor" eel-fisheries are met with on the Swedish side of the sound until we reach Råå, immediately south of Helsingborg and farther north towards the fishing station of Viken, where these fisheries come to an end. On the Danish side of the sound, however, "hommor" eel-fisheries are found both west of Saltholm, on the outer (eastern) side of Amager and farther up the sound near Humlebeck and Helsingör.* On the Danish side these fisheries cease north of Helsingör. Formerly there were eel-fisheries near Aalsgård, im-

* See G. Winther's admirable treatise, "*Bidrag til Kundskab om Fiskeriet ved Torbæk*" in "*Nordisk Tidsskrift for Fiskeri*," vol. i, p. 316.

mediately north of Helsingör, but at the present time they have ceased entirely.* Even in the Great and Little Belts, and along a part of the eastern coast of Jutland, "hommor" eel-fisheries are carried on in several places.† The above indications as to the extent of the "hommor" fisheries also show very distinctly the route followed by the eels in their migrations along the coast. We see therefrom how the eels, after having passed by certain parts of the Swedish coast, such as the coast of Södermanland, &c., finally cross over towards the Danish coast from Falsterbo, and only again make their appearance on the Swedish coast in the narrowest part of the sound, near Helsingborg.‡ The reasons why the migratory eels do not approach every portion of the coast, must probably be found in the varying depth of water near the coast, the different currents, and other circumstances as yet not fully explained. It is also possible that favorable places for these fisheries are found on those parts of the coast which, as I said above, the eels pass by, although no such fisheries have ever been attempted there. Various circumstances, however, speak against such a supposition. It is hardly probable that as easy and remunerative fisheries as the "hommor" eel-fisheries should not have been attempted in these parts of the coast, if there had been any prospect of success; and as far as I could learn from the fishermen, such attempts have been made in several parts of the coast of Scania, where "hommor" fisheries had so far not been carried on, but without success.§ I will not deny, however, that there may be some places where these fisheries have not been carried on, but which may be considered suitable for the purpose.

From olden times it has been known to the fishermen that the eels migrate along the coast, and even scientists like Kröyer, Nilsson, and others have called attention to this fact, but these migrations of the grown eels have, nevertheless, been less noticed by naturalists than they deserve, and the principal question discussed in works on the fauna has been the ascent of the young of the eel from the sea into the rivers. That a migration takes place along the coast is evident from the position in which the apparatus (the "hommor") has to be placed, if any considerable number of eels are to be caught. Along our entire eastern coast the "hommor" are placed so that the eels must enter them from the north, on the south coast of Scania from the east, and up in the Sound from the south. This circumstance can hardly be caused by an accident. On the Danish coasts of the Great and Little Belts, and other coasts,

* See J. Collin, "*Nordisk Tidsskrift for Fiskeri,*" vol. i, p. 355.

† See G. Winther, "*Om Fiskeriet i Stone Belt*" (*Nordisk Tidsskrift for Fiskeri*, vol. ii); also, "*Forsög till oversigt over Fiskeriet: Danmark vedrörende ældre og nyere Lovregler*" (*Nordisk Tidsskrift for Fiskeri*, vol. i, p. 240); and also Kröyer, "*Danmarks Fiske.*"

‡ Those parts of the coast which are visited by the eels during their migrations are marked on the map which accompanied my treatise in the German language: "*Notisen über die Schwedischen Fischereien I,*" published for the Berlin exposition.

§ Experiments will, during the present year, be made on the coast of Södermanland, the results of which will doubtless throw some light on this subject.

it is stated that the eels likewise come from the east and south, and follow a northerly direction into the Kattegat.* The fishermen everywhere declare that it will not do to reverse the position of the "hommor," as the eels invariably follow the route along the coast indicated above.† In the frequent quarrels between the fishermen about trespassing on each other's fishing-grounds, the question is never that a fishery back of another does harm to the one in front, but the very reverse. Everywhere the eels are said to approach the coast from the depths of the sea, where they follow the long arm of the "hommor" and are thus led into them. That this is actually the case appears from the circumstance that fish may be caught in rows of "hommar" placed one behind the other. This movement from the depth of the sea towards the coast does by no means, however, disprove the correctness of the opinion that, on the whole, the eels move along the coast. A circumstance speaking in favor of this opinion, is this as we shall see, that the eel-fisheries commence later in autumn the farther down we go along the coast. The approach of the eels from the depths of the sea towards the coast might easily lead us to think that the alleged migration of the eels along the coast is in reality nothing but a crossing and recrossing between the depths and the coast, but this supposition, which lies very near, is thoroughly disproved by the manner in which the "hommor" have to be placed if any catch is to be looked for. The opinion advanced by Sundevall, that, owing to some peculiarity in its "structure," the eel on our coasts should be obliged in its migrations to constantly turn to the left, seems entirely unreasonable, and that such is not the case appears from the circumstance that on the coast of Östergötland the "hommor" are in various places located on the inner or land side of the islands, and that even in this case the long arm of the apparatus must be placed on the southern side, as the eels come from the north. Since we, therefore, may consider it as certain that a migration of eels really takes place along the coasts of Sweden and Denmark, and out into the Kattegat, the question arises, "Where do these eels come from, and which is the end of their migration?"

There can hardly be any doubt that the migratory eels are, to a very large extent at least, eels which have entered the sea from fresh waters, and also that this migration is, in some way, connected with the process of propagation, and is therefore analogous to the ascent from the sea into the rivers of the salmon and other similar fish. In the foreign literature on the subject to which I have had access, I have in vain searched for information relative to similar migrations of the eels along the coast,

* See "*Nordisk Tidsskrift for Fiskeri*," vols. i and ii.

† According to information furnished by Mr. O. W. Areschoug of Esperöd, proprietor of one of the largest eel-fisheries in Scania, to whom I am indebted for many interesting data regarding these fisheries, such attempts invariably prove failures, although occasionally, when there is a southern current, a few eels may be caught in "hommor" placed with their opening towards the south.

and it therefore seems that in other countries such migrations do not occur. Löberg speaks of a kind of eel-fisheries with a sort of fish-pots on the coast of Norway, and mentions that there, too, the eels go in a southerly direction, but from his remarks it appears that these fisheries are only carried on near the mouths of rivers.* Kröyer supposes that the object of the eel in wandering along the coast is to seek deeper and salter waters, and that those eels which pass the coasts of Denmark are principally fresh-water eels from the rivers Oder, Vistula, and other rivers flowing into the Baltic.† He does not state, however, in how far he considers salt water necessary for the spawning of the eel. If this view of Kröyer, that the eels seek salter waters, is correct—and in itself it seems highly probable to suppose that salt water is of the same importance for the development of the spawn of the eel, as fresh water for the development of the spawn of the salmon and other fish, as otherwise the migration of the eels from the rivers into the sea seems utterly inexplicable—we can easily explain why the migrations of the eels along the coast are noticed particularly on the coasts of the Baltic, and especially in those parts of this sea which have an immediate connection with the salter waters of the Kattegat, but not on the coasts of England, France, or Italy, which countries are surrounded by waters which are a great deal salter than the Baltic. Löberg's statement, referred to above, regarding the migrations of the eels on the coast of Norway, seems to speak against this view, but as the migrations of the eels are, in Norway, confined to the mouths of rivers, this statement does, in my opinion, not disprove the assertion that the saltness of the water is the cause of the migrations of the eels along the coast.

In his description of the large and well-known Italian eel-fisheries near Comacchio,‡ Jacoby expresses the opinion that the migration of the eels into the sea, or the so-called "calata," is favored by the circumstance that when in summer the water evaporates, the saltness of the lagoons becomes too great, for which reason the eels eagerly seek the sea-water, which is less salty—an opinion entirely opposed to the one expressed above. The spawning process probably is the principal cause, particularly as the lagoons of Comacchio hardly contain any suitable spawning places for eels. It would, moreover, doubtless be an error to explain the migrations of the eels as exclusively depending on the character of the water, as, like the migrations of other fish, they are also caused by other circumstances, which are not yet fully understood, and which may be comprised under the head of what is called the "migratory instinct." But whatever may be the causes of the migrations of the eel, I think that it is evident from what has been said above regarding the eel-fisheries on the Baltic coast that such migrations take place, and that a more thorough investigation of these fisheries, even

*_Norges Fiskerier_, 1864, pp. 298, 299.

†_Danmarks Fiske_, vol. iii, p. 636.

‡"_Der Fischfang in der Lagune von Comacchio, &c._," Berlin 1880, p. 75.

from a purely scientific stand-point, is of very great interest, amongst the rest with regard to the question where and when the spawning of the eel takes place; for this reason I have deemed it proper to call attention to this subject, and shall now continue my review of the eel-fisheries.

THE SEASON WHEN THE EEL-FISHERIES ARE CARRIED ON, AND THE CIRCUMSTANCES WHICH ARE SUPPOSED TO INFLUENCE THE SAME.

The "hommor" eel-fisheries are everywhere confined to the latter part of summer and autumn. Near Grissleham and Landsort they are reported to begin about the 29th July, and last till the beginning of October, when night-frosts set in. On the coast of Östergötland, Kalmar, and Blekinge the fisheries also commence towards the end of July or the beginning of August, and come to a close in October, and sometimes in November. On the coasts of Scania the fisheries never begin until some time in August, and are generally but little productive until September and October. In November they decline, and if any eels are caught in December it is an exception.* In the Sound the eel-fisheries do not commence till September, and most eels are caught during October. Near Humlebeck, on the Danish side of the Sound, about one (Danish) mile southwest of Elsinore (Helsingör), the fisheries commence on the 1st of October, and always close on the 10th of November.† The further up the Sound we go, the later in autumn are the fisheries carried on, which certainly confirms the opinion that the eels wander along thecoast in a northerly direction out into the Kattegat. As regards the time when the eel-fisheries are carried on, it should be stated that darkness is the only time when these fisheries can be engaged in, and that their beginning therefore depends on the time when a change of the moon takes place. During dark nights the best hauls are made. During moonlight nights, on the other hand, none or but very few eels are caught, and most fishermen do not set their apparatus in such nights.‡ In the beginning of the fishing season the eel-fisheries are nowhere very productive, but few eels being caught during July. Under ordinary circumstances the best time for eel-fishing is in September, and higher up the sound in October. Later in autumn the fisheries gradually decline, and generally come to a close as soon as snow begins to fall. The eel seems to stir about principally during the night; during daytime hardly any

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*In the Great Belt the eel-fisheries with fish-pots do not commence till the end of September or the beginning of October, and the fish-pots are left in the water during two new moons. Near Nyborg attempts were made to continue the fisheries till Christmas, but only *one* eel was caught during December.

†J. Collin, *Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 182.

‡From information furnished by Mr. Areschoug it appears, however, that even during a full moon good hauls can be made, if the water is previously stirred up by a storm, and a light sea-breeze keeps it agitated.

are caught. As with other fish, wind and current are of considerable importance as regards the eel-fisheries. The data we possess in this respect are, however, still too incomplete to draw from them any certain general conclusions.* Near Grisslehamn southeasterly wind was considered the most favorable, but north, northeasterly, and east wind as unfavorable for the eel-fisheries. Near Landsort, south wind is considered favorable, but north and northwest wind unfavorable. Near Harstena, on the coast of Östergötland, the best eel-fisheries are said to be when the wind is south or east. West wind is not considered unfavorable, but when north wind prevails no eels are caught. On the coast north of Helsingborg south and west wind and rainy weather are considered favorable for the eel-fisheries. Near Kivik, on the eastern coast of Scanai, a faint northeasterly or easterly breeze is in some places considered most favorable, whilst in other places the same is thought as regards strong west wind. The best hauls are made with a tolerably strong northerly current.† (Areschoug.) I am strongly inclined to suppose that the different currents and the varying depth of water near the coast play an important part in the migrations of the eels, and are the principal causes why the eels, as has been stated above, in their migrations pass by certain parts of the coast. Thus an old fisherman near Ystad stated that the reason why the eels did not visit that part of the coast in any considerable number must be sought in the depth of water outside that coast, where the eels, instead of going towards the land, turn and go out to sea again. Among other conditions of the weather which are considered to have an influence on the eel-fisheries, cloudy and rainy weather seem, as a general rule, to be considered favorable. Near Kivik great heat during summer, and calm, which favors the so-called "blooming" of the water (the development of a kind of floating algæ), seem to be favorable for the eel-fisheries. The eel is always said to seek a bottom overgrown with grass and algæ, and the fishermen, therefore, like to set the "hommor" on such bottom; but also on stony bottom, as is generally found on our coasts, and on sandy bottom (the coast of Scania) with or without vegetation. If, as is generally the case, in Blekinge and Scania, the "hommor" are set in rows, one back of the other, sometimes to the number of 30, the catch is but rarely distributed evenly among all the "hommor," but more fish are generally caught in those nearer the land than in those on the outside. Near Kivik it has been observed that during west wind the eels come very near to the land, whilst during east wind they go farther out to sea. (Areschoug.)

* Kröyer states that the eels leave the coast during land wind, but approach it again when the wind blows over the land.

† In the Great Belt south wind is in some places, and north wind in others, considered favorable; for both these winds cause a faint current along the coast, and keep the water a little agitated, which causes the eels to halt in their wanderings. G. Winther, *Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 251.

FISHING APPARATUS, AND THE MANNER IN WHICH THEY ARE USED.

The so-called "hommor" are, as has already been stated, a kind of fish-pot, varying in size, but always constructed on the same principle. In accordance with different local circumstances and usages, there are, however, some differences in this apparatus, which at first sight cause a casual observer to think that what is really one and the same apparatus, is a variety of different apparatuses. One can principally distinguish two kinds: those which are intended to be placed on stony bottom, and those which are used on even sand or clay bottom. To the first kind belong the apparatus used on the coasts of the districts of Stockholm, Östergötland, and Kalmar, and to the second, those used on the coasts of Blekinge and Scania. The former are generally smaller and narrower. As a good representative type of this apparatus the one used on the coast of the Kalmar district may be taken. It has only one arm, varying in length from 15 to 42 feet, according to the depth of water in which the apparatus is set, starting from the left side of the opening.*

Here begins the so-called "hat," consisting, like a common fish-pot, of a semicircular hoop, from 3 to 4 feet across, and following this, rings, at intervals of 1 foot, gradually decreasing in size, so that those at the farther end measure only 6 to 8 inches in diameter, the whole being covered with netting. At the end of this so-called "hat" (generally 15 to 24 feet long), which like a fish-pot has funnel-shaped entrances, there is fastened the so-called "tub," plaited of thin branches, in which the eels are finally caught. To keep this "tub" steadily in position, it is placed on a frame-work of wood. The apparatus is anchored, and held in position by ropes† to which tolerably heavy stones are fastened. To each stone there is moreover fastened a line with a float, by which the line is hauled in, when the apparatus is to be emptied or taken up. Near Örö (in the district of Kalmar) four similar weights (two on each side) are used for the wide part of the apparatus, a like number to keep the arm in position, and one large stone for the "tub." In stormy weather it becomes necessary to make use of more anchoring to keep the apparatus in position. To prevent the eels from going under the arm, which might be the case, especially when the bottom is very uneven, the lower part of the arm is pressed a little against the net through the meshes, so that its lower part comes to lie close along the bottom.

Near Landsort the so-called "tub" is not used, whilst it is in use in the northern part of the coast of the Stockholm district; as for the rest, the apparatus used north of Kalmar is in its main outlines the same as the one we have described. From those used in the south of

* Right and left counted in the direction of the apparatus, looking forward from the narrow end of the apparatus.

† In the district of Kalmar ropes are used for this purpose, plaited of very thin branches. These ropes are stronger and more durable than one would suppose, and are frequently used as hauling-lines both in the north and south of Sweden.

Sweden it differs by its long shape and its many rings. The apparatus used near Kivik may be considered as the type of those used in Blekinge and on the eastern and southern coasts of Scania. They are often very large; the arms especially are of considerable length (the long arm 60 to 80, and the short arm 20 to 30 feet; height of the arms 6 to 8 feet). The apparatus proper is 16 to 24 feet long, with a main hoop 4 to 5 feet high (not semicircular), and 5 or 6 rings, at intervals of 3 feet, decreasing in diameter towards the back part of the apparatus, but never quite as small as those described above. No special "tub" of wicker-work is used. On the south coast of Scania the apparatus are smaller than those used on the east coast of Sweden, but otherwise of the same general construction. In the Sound smaller apparatus are also used. The front ring or hoop measures about 2½ feet, and the other two 2 to 1½ feet, respectively, in diameter. Here a so-called "tub" of wicker-work is used. The apparatus proper without this "tub" measures about 10 feet in length. The "tub" is made of willow branches, and has the same shape as those described above. In plaiting this wicker-work the longest switches are allowed to protrude and are twisted together, so as to form a sort of handle at the end. This handle serves to fasten the cable by means of which the "tub" is anchored. The anchor is nothing but a number of large stones resting on a cross-shaped wooden foot, from which extend four branches, which surround the stones, and above are joined in a sort of loop. These kinds of anchors are used even for so-called "bottom-nets."

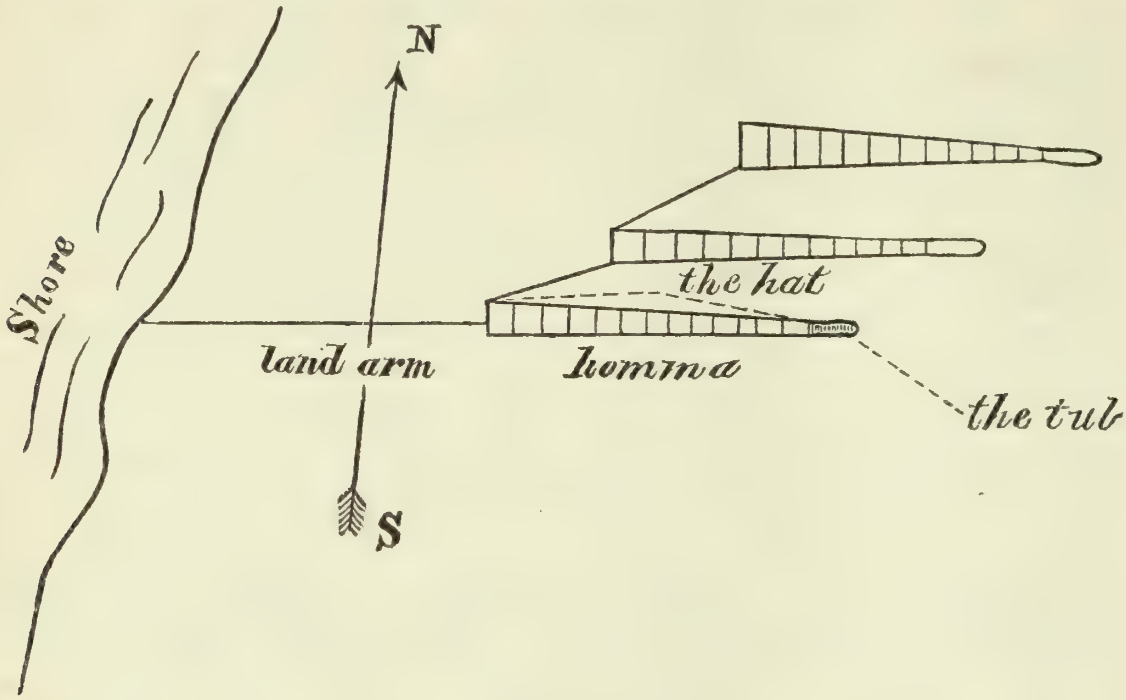
The "hommor"* are here set in a manner differing somewhat from the one generally used, which, however, it would be difficult to understand without a diagram. At the farther end of the apparatus there is fastened a pole, thicker below than at the top, and furnished with a sort of fork, to which are fastened three ropes with anchors, which serve to keep the apparatus in position. These ropes are called after the point of the compass in which the anchor is placed, *e. g.*, the "southeast rope," the "southwest rope," and the "northeast rope;" the "tub" is held in position by a separate anchor, from which, and from the handle mentioned above, a double line extends to the pole, which serves to haul in the apparatus, or to change its position, or to empty the "tub." The "tub" is then loosened from the apparatus proper, emptied, and again fastened to it. In the Sound two arms are also used, a long one (72 to 96 feet long) and a short one (8 feet long). Near Helsingborg no anchors resting on a wooden frame are used, but simply stones tied with ropes.†

Where local circumstances permit, several "hommor" are generally placed in a row, one behind the other, starting from the shore. The more sloping the bottom the larger may be the number of "hommor,"

* These eel "hommor" seem to be the same as the apparatus called in Denmark *Kasteruser*. (*Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 239.)

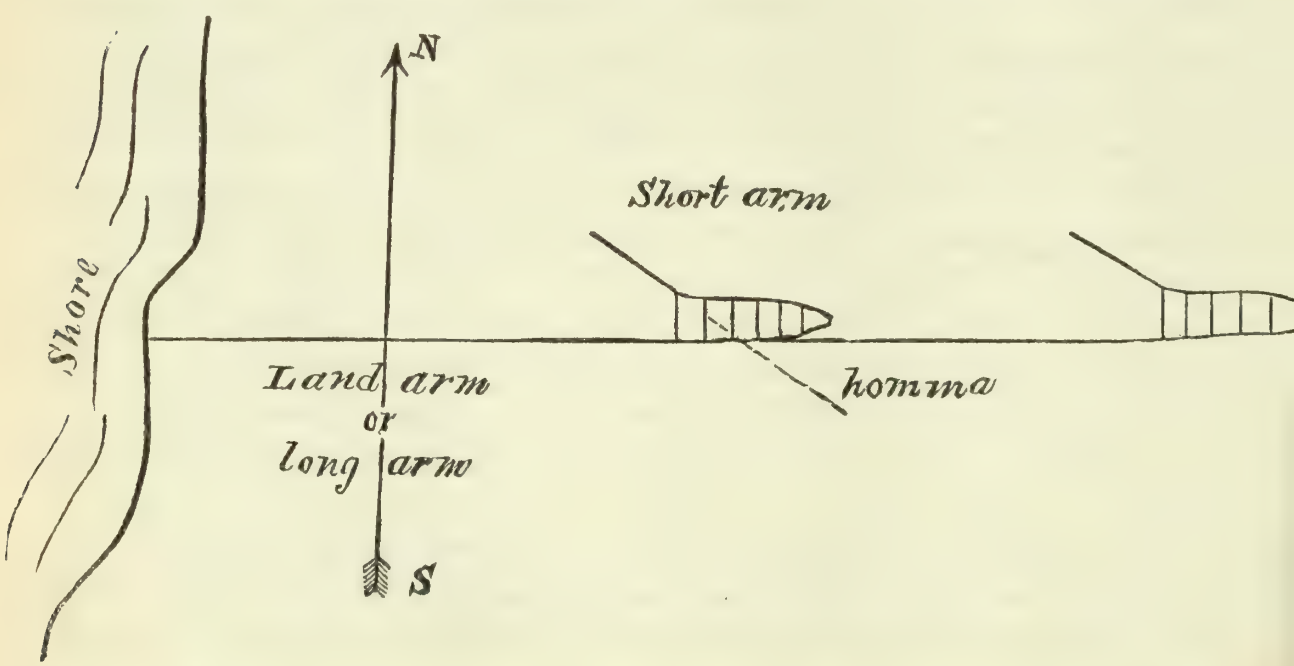
† A full description of the Danish eel-traps has been furnished by J. Collin in *Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 374.

placed one behind the other. Near Grissleham the "hommor" are placed by the side of each other, generally at intervals of 10 and sometimes 5 fathoms. Near Landsort the "hommor" cannot be placed one back of the other, owing to the steep and stony bottom. Near Örö



(Kalmar district) 3, at most 4, "hommor" are placed one behind the other, as shown in the drawing.

In Blekinge and on the east coast of Scania the "hommor" are placed one back of the other in such a manner that each succeeding "hommor's" long arm commences about the middle of the preceding one. (See drawing.) In order, if necessary, to draw on land the entire row of



"hommor" they are united to each other by strong ropes (on certain portions of the east coast of Scania), or (on the south coast of Scania) the lower part of the long arm of the succeeding "hommor" is tied to the lower part of the short arm of the preceding one. According to

Areschoug the places where eel-fisheries are carried on have been called "*drätter*" (from "*draga*"=to draw), whilst near Esperöd, where the "hommor" are not bound together, they are called "*sätter*" (from "*sätta*"=to set). In the Sound it is not thought worth while to set "hommor" except on grassy bottoms, and the number of "hommor" is therefore limited by the extent of these bottoms. Near Råå only 4 "hommor" are, for this reason, placed in a row one behind the other, whilst near Helsingborg 16 are set. Each succeeding "hommor" is placed right back of the preceding one, so that its long arm reaches up to the "tub" of the preceding one.

The eel "hommor" are a large apparatus, and are therefore comparatively expensive. Near Grisslehamn the price of a "homma" is 50 crowns [$13.40]. Near Örö (in the Kalmar district) the price is 20 crowns [$5.36], and with the ropes belonging to it 30 crowns [$7.04]. The large "hommor" used on the east coast of Scania and in Blekinge cost 100 crowns [$26.80] apiece. On the south coast of Scania smaller "hommor" are used, which cost 16 crowns [$4.28] apiece. Near Råå a "homma" costs 50 crowns [$13.40]. If, as is the case in many places, as many as 30 "hommor" and more are placed in each row, they represent a very considerable capital.

THE YIELD OF THE EEL-FISHERIES WITH "HOMMOR."

It has been impossible so far to obtain full data relative to the yield of the eel-fisheries along the entire stretch of coast where the fisheries are carried on.* But even from the data which we possess it appears that the eel-fisheries with "hommor" are of considerable economical value. From the Stockholm district a few statistics are given, which to some extent will show the value of these fisheries. Thus, at Byholma, where 11 fishermen own 50 to 60 "hommor," the total average yield per annum was 3,720 pounds of eels. The eels are shipped to Stockholm, and generally are sold at 10 crowns [$2.68] per "lispund" [=18.6 pounds]. The gross income from these fisheries, therefore, amounted to 2,000 crowns [$536]. On the southern part of the same coast, near Landsort, 1,395 pounds of eels were caught last year, which, at the price of 8 crowns [$2.14] per "lispund," would represent a sum of 600 crowns [$160.80]. From the statistics given below, taken last year by Mr. V. Wahlberg, regarding the eel-fisheries on the coasts of Östergötland and Kalmar, it appears that the gross receipts from the "hommor" eel-fisheries were 17,010 and 27,900 crowns [$4,558.68 and $7,477.20], respectively, the price per "lispund" being only 6 crowns [$1.60]. Some years, however, the eels fetch 7 crowns [$1.87] per "lispund," and these prices must be considered as, on the whole, somewhat below the average. From Blekinge we have but few statistics. In 1878 there were in the

* Special statistics of the Scania eel-fisheries have only been furnished for the last two years. Previous fishery statistics did not give separate statistics for each fishery.

district of Kristianopel 185 "hommor," in which there were caught about 18,600 pounds of eels, representing a sum of about 7,000 crowns [$1,876]. In the districts of Thorshamn and Sturkö, with the islands belonging thereto, the number of "hommor" in 1878 was about 1,000. No data could be obtained as regards the number of eels caught. The number of "hommor" in the western part of this district, from Pukavik as far as Nogersund, is estimated at about 600, and in 1879 about 93,000 pounds of eels were from this district sold to German fish-dealers, which, at a low calculation, would represent the sum of at least 50,000 crowns [$13,400]. The receipts from the eel-fisheries in the Christianstad district in 1879 were 138,600 crowns [$37,154.80]. We have, however, no data from some of the fishing stations in this district, and the receipts from these eel-fisheries may, in favorable years, be put down at about 145,000 crowns [$38,860]. In the Malmö district the eel-fisheries are comparatively insignificant.

As will be seen from the statistics of the last two years, the eel-fisheries vary greatly in different years.

TABLE I.—*Statistics of the eel-fisheries with "hommor" in the districts of Östergötland and Kalmar in* 1880, *gathered by V. Wahlberg.*

Districts.	Number of fishermen.	Number of "hommor."	Number of pounds of eels caught.	Gross receipts.
Östergötland	86	312	52,731	$4,557 68
Kalmar	240	1,144	86,490	7,477 20
Total	326	1,456	139,221	12,034 88

TABLE II.—*Statistics of the eel-fisheries with "hommor" on the coast of Scania during the years* 1879 *and* 1880.

1879.

Districts.	Number of fishermen.	Number of "hommor."	Number of pounds of eels caught.	Gross receipts.
Christianstad	297	4,438	372,539	$37,152 57
Malmö	139	1,662	30,894	3,379 48
Total	436	6,100	403,433	40,532 05

1880.

Districts.	Number of fishermen.	Number of "hommor."	Number of pounds of eels caught.	Gross receipts.
Christianstad	356	4,689	162,973	$15,934 24
Malmö	237	2,022	41,050	4,010 35
Total	593	6,711	204,023	19,934 59

During the year 1879 the eel-fisheries were unusually productive, whilst in 1880, when stormy weather greatly interfered with them, they were in most places even below the average. Mr. Areschoug, of Esperöd, has kindly furnished the accompanying (see plate) interesting graphic

representation, showing the variations of the Esperöd eel-fisheries during the period 1815–1879, from which it appears, amongst the rest, that the year 1879 was the most favorable year during the entire period. Mr. Areschoug justly thinks that, as the fisheries in the other parts of the east coast of Scania are very much like the Esperöd fisheries, said table will give a tolerably correct idea of the variations of the eel-fisheries during that period on the entire coast. It will hardly be necessary to state that data as to wind and current, during this long period, would be exceedingly valuable.* Although the eel-fisheries are generally continued for a period of three months, the richest hauls are generally made during a much shorter period, when the great mass of eels passes the coast, before and after which the yield is generally much smaller. The same is also the case as regards the salmon-fisheries in the rivers. As an illustration, we will state the following relative to the Esperöd fisheries in 1878, kindly communicated by Mr. Areschoug: "Up to September 24th but few eels were caught (18 to 36 pounds a day in each row of 'hommor'), the prevailing wind being west wind. On that day it commenced to blow from the NNE., but not enough to prevent the apparatus from remaining in position. This wind continued for several days, the current being northerly. The wind afterwards changed to SE. and S., but, as a general rule, the wind was more or less north till October 12th, when a gale commenced to blow from the east, which continued till October 25th, cast the apparatus ashore, and put an end to the fisheries. The fisheries of that year actually lasted from September 24th till October 12th, during which period 20 to 70 "lispund" [372 to 1,302 pounds] a day were caught in each row, the yield, therefore, being somewhat above the average. This, however, was an exceptional case." This communication is of special interest as showing the influence of wind and current on the eel-fisheries.

EXTENT OF THE DIFFERENT CATCHES, PRICES PAID FOR EELS, PREPARING EELS, AND PRINCIPAL MARKET FOR EELS.

As the greatest catches in one day in one and the same row of apparatus, Areschoug mentions 90 to 110 "lispund" [1,674 to 2,046 pounds]. At the present time catches of 50 to 60 "lispund" [930 to 1,116 pounds] a day are very rare. It is not stated how many "hommor" were used. Near Örö (Kalmar district) 40 to 60 eels per "homma" is considered a good catch. Catches of 100 to 220 eels per "homma" are regarded as exceptional. The eels, especially in the north, fetch a very good price, and in this respect rival the salmon. The greater portion of the eels are sold, fresh, to fish-dealers.

From the neighborhood of Grissleham the eels are sent to Stockholm, in long, narrow boxes, made of four boards, and resembling a wooden

* It has been resolved that from the present year daily observations of wind and weather, as well as the temperature of the water, shall be taken by the superintendents of the different eel-fisheries.

sewer-pipe. These boxes are taken in tow by lumber ships sailing to the capital. The price obtained was generally $2.68 per 18 pounds. At Landsort about one-third of the catch is consumed at home, and two-thirds sent to Södertelje or Stockholm. On the coast of Östergötland and North Kalmar the eels are generally bought by fish-dealers from Norrköping or Stockholm, who visit the principal fishing stations, such as Harstena, and gather the fish in their sailing vessels. In Blekinge and Eastern Scania the greater portion of the eels has, for some years, been sold to German fish-dealers, who keep fishing-smacks on this coast during the entire period of the eel-fisheries. From time to time steamers come from Germany, gather the eels from the fishing-smacks, and take them to Stettin, whence they are sent to Berlin. According to a contract with the Hörvik fishermen, which I had the opportunity to see, the German dealers last year agreed to pay per 19½ pounds [21 Swedish "skålpund"] 8 crowns [$2.14] in September and October, and 7½ crowns [$2.01] in August. At Råå the eels vary in price according to their size. Of good eels 20 or 21 should generally go to 1 "lispund" [18.6 pounds], and are sold for 8 crowns [$2.14], whilst smaller eels are sold for 5 crowns [$1.34] per "lispund" [18.6 pounds]. Here, as in general along the entire south coast of Scania, the eels are sold in the country to farmers and dealers. It is only since last year that German dealers have visited the Kalmar district, where they had one fishing-smack. There is, therefore, no lack of remunerative and convenient markets, at least as far as the great eel-fisheries are concerned. The great portion of the eels caught on the coasts of Blekinge and Scania are, at the present time, sold fresh, and only small quantities are salted, either for domestic consumption or by salters. On the Kalmar coast a considerable number of eels are salted, and principally sold at the Norrköping autumn fair. The eels are laid in salt brine alive, are then put in kegs and salted once for all (that is, are not taken out again). Near Örö, on the coast of Misterhult, the price of salt eel was about 9 crowns [$2.41] per "lispund" [18.6 pounds]. Twenty-two "skålpund" of fresh eels are generally calculated to make 15 "skålpund" of salt eel. [The skålpund = $\frac{13}{14}$ of a pound. This shrinkage is about one-third.]

OWNERSHIP OF THE EEL-FISHERIES; THE EEL-FISHERIES IN OLDEN TIMES.

The eel-fisheries with "hommor" are, as appears from the above, exclusively coast fisheries, which in most places are carried on within certain well-defined limits, called in Swedish eel "*drätter*" or "*sätter*" (corresponding to the Danish "*aalestader*" or "*aalegaarder*" (eel towns or eel farms). They are frequently known by special names, "*kyledrätten*," "*kungsören*," &c., and their boundaries are well defined till within a few yards from the shore. These eel-fishing places are in Scania and Blekinge considered taxable property. A great portion of the eel-fisheries on the east coast of Scania seem originally to have

belonged to the state, and have since been sold to private individuals. As regards many of them we find it stated that they were bought by the proprietors of Torup in 1697; but as late as 1850, 92 eel-fisheries in the district of Kristianstad are mentioned as belonging to the state, which, however, by royal decree of March 22, 1850, were either sold, or, under the name of "fish revenues," leased to different parties. The same was the case on the coast of Blekinge. In the district of Malmö the state seems to have owned but few eel-fisheries, which shows that the fisheries in that district were not very important (only two fisheries are mentioned to which the fishery regulations of 1850 applied). As far as I could ascertain there were no state or taxed eel-fisheries on the remaining portions of our Baltic coasts. In Nilsson's "Fauna" it is stated that taxed eel-fisheries are found on the coast as far north as Hernösand, but this statement is probably based on a mistake, and refers to the taxed eel-fisheries farther inland. All the taxed eel fisheries are treated as property, for which a certain tax is paid. According to the old Danish law, the so-called "*forstranden*" (coast front), and therefore the right to fish in its waters, belonged to the King, who gave it to his subjects, either free or for the payment of a certain rent. It appears from old documents that the nobility enjoyed special privileges to have free fishing and eel farms on portions of the coast belonging to them—privileges which were not enjoyed by any and every owner of property along the coast. This exclusive right of the noble owners of eel farms to carry on these fisheries in the sea was by the law of Christian V extended to all owners of such fisheries. As most of the eel-fishing grounds were probably taken up before these provinces (Scania and Blekinge) were ceded to Sweden, no new eel-fisheries have sprung up besides those which had been carried on from time immemorial. In certain portions of the west coast of Scania, *e. g.* near Råå, the eel-fisheries have been free. There is only one place where eels are caught which belongs to farmers, the rest of the fishing places being determined by the fishermen by mutual agreement. The one who first marks the place by anchoring the pole described above is considered to have the right to fish in that place during the year. Near Grisslehamn the fishing water is divided among the shareholders in certain parts, which are worked in turn and are changed every eighth day. If, for example, a shareholder has part *a*, he changes to *b* after eight days,

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*

and so on; and if he closes the year's fisheries with part *e*, he commences at *f* in the following year. Every part is intended for four "hommor," but the owner has the right, if he desires, to set more. Quarrels arise very frequently among the owners of eel-fisheries, caused by trespassing on each other's fishing grounds, by one of the owners of a preceding part setting too many "hommor," and thus diminishing the number of eels going into the succeeding "hommor," &c. As it some-

times happens that one and the same row of "hommor" has several owners, the outer ones belonging to one and the inner ones to another, there is frequent occasion for quarrels and lawsuits. As was stated above, the distances between the different eel-fisheries are generally carefully defined, as well as the number of "hommor," but there are no rules as to how far from the coast the right of fishing shall extend. As the price of eels has risen the fisheries have sometimes been extended as far as local circumstances would permit. At the present time the "hommor" are set out much farther and in greater number than was the case formerly. Thus, near Kivik, "hommor" are now set at a depth of 9 or 10 fathoms. The fishing population proper, however, is excluded from these easy and profitable fisheries, and, displeased with this, they have during the last few years, in several places, attempted to set "hommor" beyond the boundary lines of the old fishing grounds, claiming that these could not extend farther than the so-called land ground (*land-grund*) extends according to the fishery law of 1852. This has given rise to quarrels and lawsuits between the fishermen and the owners of the taxed fisheries. The same has taken place in Denmark, where circumstances are very similar. It is certainly not to be wondered at that the fishermen feel hurt at seeing themselves exclusively confined to the difficult and, comparatively speaking, less remunerative sea fisheries; but, on the other hand, it cannot be denied that an equitable arrangement of the mutual rights would in this case be connected with great difficulties. It is, at all events, desirable that there should be some distinct legislation on this point. As for the rest, there does not seem to be any necessity for other administrative measures relative to these eel-fisheries.

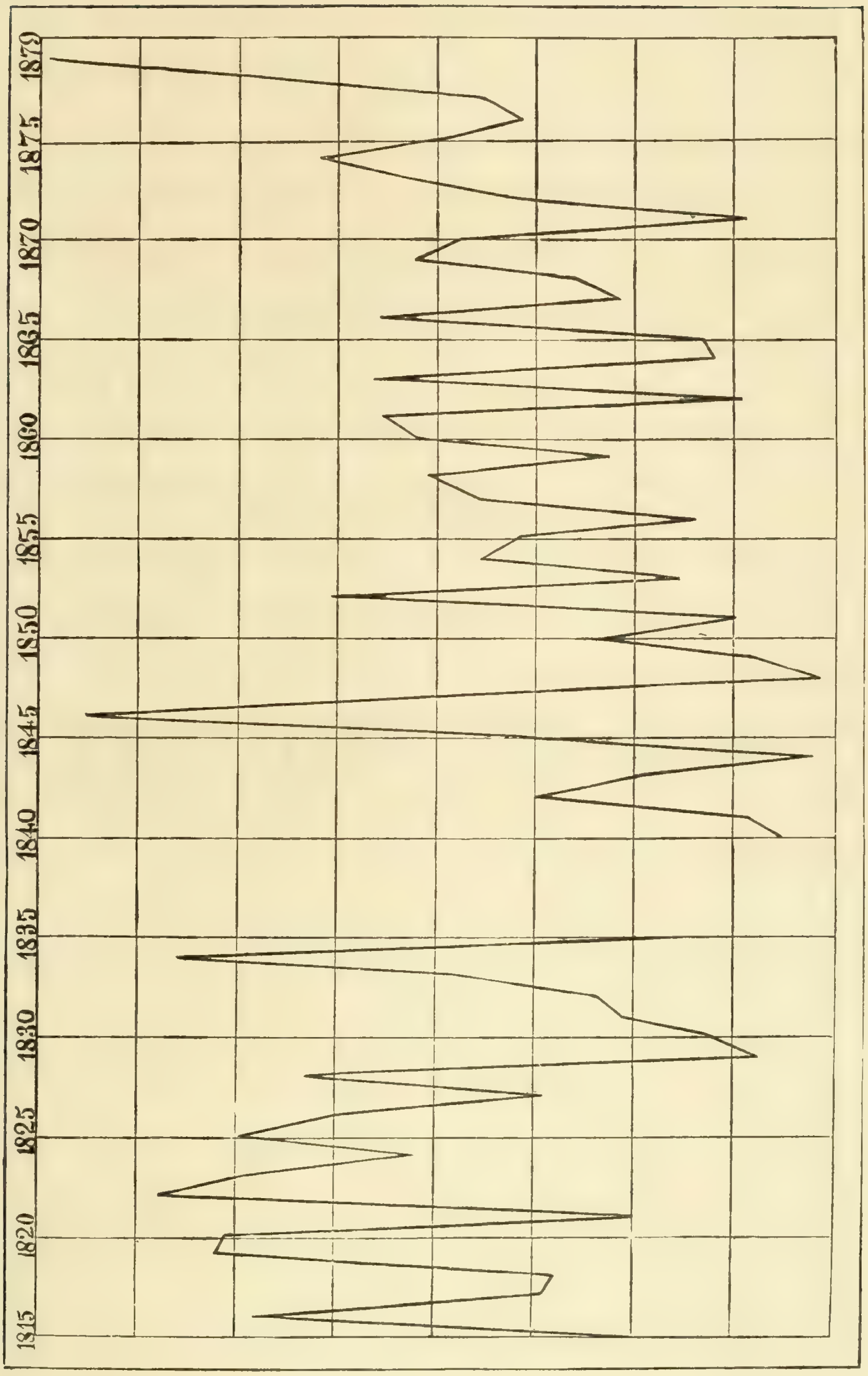


Table showing the variations in the Eel-fisheries near Esperöd and Kivik, in Scania, from 1815 to 1880, by O. W. Areschoug.

APPENDIX C.

ECONOMIC RESEARCH.

XV.—CONTRIBUTIONS TO THE KNOWLEDGE OF THE CHEMICAL COMPOSITION AND NUTRITIVE VALUES OF AMERICAN FOOD-FISHES AND INVERTEBRATES.

By W. O. Atwater, Ph. D.,

Professor of Chemistry, Wesleyan University, Middletown, Conn.

The report of the Commissioner of Fish and Fisheries for 1880 contained a preliminary "report of progress" of an investigation of the subject named as title of this article. The investigation has since been prosecuted as time and circumstances allowed, so that a considerable amount of material has accumulated. It is my aim to collate and prepare this for publication as soon as may be. Meanwhile, at the request of the editor, I state here a few of the results of that branch of the research which has to do more particularly with the nutritive values of the fish and invertebrates.

The investigation embraces—

I. Chemical analyses of the flesh of American food-fishes and invertebrates.

II. Experiments upon the digestibility of the flesh of fish.

III. Studies of the constitution of the flesh of fish.

I. *Chemical analyses of the flesh of the American food-fishes and invertebrates.*

The larger part of the results obtained in the chemical analyses are of interest chiefly in their bearing upon the nutritive values of the materials. A not inconsiderable portion of the work done in connection with the analyses has, nevertheless, like the study of the constitution of the flesh, been of a decidedly theoretical tendency. Indeed, I can see no reason why I should not frankly say that, so far as my own connection with the investigations is concerned my chief interest in it has been that of the biological chemist, a sentiment which I think is warranted, if by no higher considerations, by the very simple fact that in the present condition of human knowledge and progress the most abstract research is a condition of the best practical results. The investigation in its present status includes the chemical analyses of—

(*a*) Flesh of fish	118 specimens of 51 species.
(*b*) Flesh, &c., of invertebrates	64 specimens of 11 species.
Total food-fishes and invertebrates	182 specimens of 62 species.

Along with these a parallel series of analyses of meats, dairy products, and other food materials, animal and vegetable, have been undertaken, at the instance of the United States National Museum, to furnish data for illustrating and explaining its food-collection. These analyses, though not specifically a part of the investigation herewith reported, form a most important supplement to it, because of the great desirability of data for comparisons of fish with other foods. The number of analyses of the latter kind already made is 90. These, with the 182 of food-fishes and invertebrates, give a general idea of the amounts of nutritive substances in our more common foods. Of course, an at all complete and satisfactory knowledge of the subject will require the prosecution in much more detail of the work of which these analyses represent only the beginning.

II. *Experiments upon the digestibilty of the flesh of fish.*

The importance of studying the digestibility of the flesh of fish led me to improve the occasion of a stay in Munich, Germany, to conduct a series of experiments upon this subject. In this I was very materially aided by Professor von Voit, who courteously placed the needed room and appliances in the physiological laboratory of the University at my disposal, and rendered material assistance by his counsel.

The general outcome of the experiments may be expressed in a few words. The proportions of the nutrients digested were tested in a series of experiments with a healthy man and with a dog. The man digested some 98 per cent. of the protein of the fish and nearly the same proportion from meat (lean beef). That is to say, the digestion of the protein of both meat and fish was nearly complete. Essentially the same results were obtained for the other nutritive ingredients. The experiments with the dog gave practically like results with both kinds of food.

Regarding the ease and rapidity of the digestion of fish, the experimental evidence is as yet insufficient for exact conclusions. The investigations thus far made upon the constitution of the ingredients of the flesh, as well as those upon artificial digestion, indicate no great difference between the fish and the leaner meats, as lean beef, and imply that both would be very readily digested. In brief, the experimental facts at hand do not indicate any decided difference in digestibility between fish and the leaner meats. Both belong to the more readily and completely digestible foods.

III. *Studies of the chemical constitution of the proximate ingredients of the flesh of fish.*

It was my fortune to spend some months in Heidelberg, where Professor Kühne, of the University, kindly offered me the facilities of the physiological laboratory under his charge, and added his own valuable assistance in the prosecution of an inquiry into the constitution of

some of the albuminoid compounds of the flesh of fish as compared with those of mammals. This included with other matters the experiments upon artificial digestion above referred to. I have not yet been able to complete the investigation. The results obtained, however, point to a very great similarity between the flesh of our food-fishes and that of the domestic animals we use for food. I hope to be able to continue the inquiry and to present its results hereafter.

The present report includes only the analyses of fish and invertebrates, referred to above as already completed, and such brief explanations as its purpose, that of a record of the chief statistical facts in the form of a report of progress, seems to require.

The details of the chemical analyses have been performed, for the most part, by my assistant, Mr. C. D. Woods, with the aid of Mr. E. B. Voorhees, to whose skill and faithfulness I am happy to bear testimony.

In the report referred to above I had the pleasure of acknowledging contributions of one hundred dollars each from Mr. A. R. Crittenden of Middletown, Conn., and Mr. E. G. Blackford, Fish Commissioner of the State of New York, to which latter gentleman, as well as to Mr. G. H. Shaffer, of the firm of Dorlan & Shaffer, of New York, thanks are due not only for a very large number of the specimens of fish and invertebrates, but also for collateral information of no little value. It is a source of no little gratification to be permitted to add that Mr. F. B. Thurber, of New York, has generously contributed $500 toward the expenses of the analyses of foods, other than fish, just mentioned, and that a still larger sum has been furnished by the liberality of Hon. J. W. Alsop, M. D., of Middletown, Conn., in aid of researches in the laboratory, a considerable portion of which has been used in defraying the cost of the studies in the chemistry of fish. These with some other gifts from private sources have, with a larger amount appropriated to the purpose through the courtesy of Prof. S. F. Baird, Secretary of the Smithsonian Institution and United States Commissioner of Fish and Fisheries, defrayed the incidental expenses of the investigation for assistants, materials, &c., and thus rendered it possible.

ANALYSES OF FISH.

Tables I to X, herewith, contain a *résumé* of the analyses of the flesh of 99 specimens of fish, and of 19 samples of prepared fish-foods, making 118 specimens belonging to 51 species of American food-fishes. They give, however, only such of the data as are most important in their direct bearing upon the food values. The further details, which include descriptions of specimens, the composition of the water-free as well as the fresh substance, and numerous determinations of organic and inorganic constituents not mentioned here, will, I trust, be published elsewhere in the near future.

The methods employed in preparing the materials for analysis and

in the analytical determinations have been described in the preliminary report* above referred to, and in less detail in the *Berichte der Deutschen chemischen Gesellschaft*, xvi, 1883, s. 1839. It will therefore suffice here to refer to them very briefly.

Separation of edible portion (flesh) from refuse (bones, skins, entrails, spawn, &c.).—The sample, as received at the laboratory, was weighed, the edible portion, "flesh," was then separated from the refuse, and both were weighed. There was always a slight loss in cleaning, due, evidently, to evaporation and to slimy and fatty matters and small fragments of the tissues that adhered to the hands and to the utensils used in preparing the sample. Perfect separation of the flesh from the other tissues was difficult, but the loss resulting from this was small, so that, though the figures obtained for edible portion represent somewhat less than was actually in the sample, yet the amount thus wasted was doubtless scarcely more than would be left unconsumed at an ordinary table. The reasons for rejecting the skins, which generally has considerable nutritive value, were that its chemical constitution is different from that of the flesh, and that, so far as we have observed in this country, it is not ordinarily eaten. With the closer domestic economy that increased density of population must bring, people will doubtless become more careful hereafter to utilize such materials.

Water, and water-free substance.—The material is carefully sampled and partially dried at 95° centigrade, or thereabouts, generally in a current of hydrogen, then finally ground and the drying completed in hydrogen. The residue, after removal of all the water, is called water-free substance.

Nitrogen, albuminoids.—The nitrogen is determined by the soda-lime method. The results of a not inconsiderable amount of labor devoted to the study of the conditions under which this method yields correct results have been partially and briefly recapitulated in the accounts above referred to. We have come to believe that with proper precautions extremely accurate determinations may be made with soda-lime but that great care is needed to insure them.

It is customary to compute the albuminoids or protein by multiplying the nitrogen by 6.25. In our analyses this factor has in general been very nearly correct. The subject, however, demands extensive discussion, for which this is not the proper place. I have thought it more to the present purpose to state the percentages of nitrogen, and instead of giving the protein as calculated by multiplying these by 6.25, or any other factor, to estimate the albuminoids by difference. That is to say, the remainder, left after subtracting the sum of ether extract and ash from the water-free substance, or the sum of water, ether extract, and ash from the fresh substance, is taken as the percentage of albuminoids. This is, of course, not absolutely correct, but it is more

* Report of the U. S. Commission of Fish and Fisheries for 1880, Washington, 1883. Appendix D, pp. 242-248.

nearly so than the product of nitrogen by 6.25 would be, and in fact varies but very little from the exact truth. For that matter the protein, as ordinarily estimated, would be so near the truth as to make the variations of but little practical importance as regards the nutritive values. In the analyses of fresh fish there were no cases in which the sum of water, protein ($N \times 6.25$), fat, and ash fell below 99, and but three in which it rose above 101 per cent. In the dried fish the variations were of course wider.

Fats; ether extract.—The figures for fats denote the amounts dissolved out by ether and properly denominated ether extract. In the extraction, which is conducted by use of the apparatus described by Johnson,* we find it advisable to repeat the extraction with fresh flasks until weighing of the latter shows no considerable amount of extract rather than to depend upon evaporation of the percolating ether upon a watch-glass or any other ocular test. The extract is freed from ether by heating at 95° C. in a current of hydrogen. I think that the extract, as determined in this way, in the flesh of fish, represents very closely the actual amount of fat.

Mineral matters; ash.—The ash is determined in the usual way by carbonizing, extracting with water, incinerating, adding water-extract, drying, and incinerating again.

TABLES OF ANALYSIS OF FISH.

The tables show the percentages of water, water-free substance, nitrogen, albuminoids estimated by difference, as above explained, and ash or mineral matters in the flesh—*i. e.*, edible portion of the fish. The number of specimens analyzed of each kind is shown in the first column. Where more than one specimen was analyzed the average is given, and in case the differences were marked the maximum and minimum percentage of each constituent is stated.

Table V gives the composition of the fish, as found in the markets, including both the refuse, bone, skin, entrails, &c., and the edible portion. Some of the specimens were entire, others dressed, as indicated in the table by the terms "whole," "entrails removed," &c.

From the purely economic standpoint this table is the more interesting one since it represents the composition of the fish as ordinarily sold, and thus shows the amounts of nutritive materials which people ordinarily receive in return for the money invested. Further statements regarding the economical bearings of the figures in the tables will be given beyond.

ANALYSES OF INVERTEBRATES.

Table VI herewith recapitulates the principal results of the analyses of 64 specimens of invertebrates (two of vertebrates) belonging to 11 species. As the variations in the composition of different specimens of

*Am. Jour. Sci. [3], 1877, 190.

the same species are very wide, a fact especially noticeable in the oysters; and as this is a matter of no little economic interest, I give the results of individual analyses as well as the averages.

It will be observed that with oysters, clams, &c., the composition of both the flesh (so-called "solids") and the liquid portion of the shell contents is given. Other tables have been prepared stating the proportions of flesh and liquids in the edible portion, proportions of edible portion and refuse (shells, &c.) in whole specimens, and numerous other details; but on account of their bulkiness are not inserted here. In the last columns of Table VI, however, under the heading "In whole sample," are given the percentages of total edible portion and of total water-free substance in the specimens as received for analysis. Thus, in the last column but two, we have the weight of total edible portion (which includes both flesh and liquids in the oysters, clams, and mussels) in 100 parts of each specimen. The percentage of refuse, shells, &c., may be found by subtracting the total edible portion in each case from 100. The last column but one gives the percentage of water-free substance (actual nutrients) in each case. This subtracted from the total edible portion will show the percentage of water in the latter.

As the data of Tables IV and V express the facts only incompletely, I have selected from other tabular statements that have been prepared for future publication, Tables I, II, III, and IV, which show the results of the analyses of fish more fully, as explained in the appendix, in which several of the larger tables are placed for convenience.

While, as said above, I do not deem this exposition of the more practical results of the investigation the proper place for discussing its theoretical aspects, I trust it may not be out of place to speak in somewhat greater length of the relations of the amounts of nitrogen to the amounts of the nitrogen compounds than was done in describing the methods of analysis.

It was there stated that the amounts of protein, as computed by multiplying the nitrogen by 6.25, differed in some cases very materially from the amounts as computed by subtracting the sum of the ether extract and ash from the whole water-free substance. Or, to put it in another way, the sum of the percentages of ash, ether extract, and protein thus computed, in water-free substance, varied considerably from 100, in several cases. This is illustrated by the following figures from Table I, which include all those in which the sum of these percentages in water-free substances varies 2 per cent. or more from 100. The variations in the flesh are, of course, less.

Sum of Protein ($N \times 6.25$) *ether extract, ash and water in flesh of fish.*

Laboratory number.	Name.	Protein + ether extract + ash in water-free substance.	Protein + ether extract + ash + water in flesh.
40	Spent land-locked salmon	97.01	99.34
41	do	98.00	99.59
7	Striped bass	102.03	100.43
47	Herring	102.07	100.66
250	Sheepshead	102.08	100.43
229	Haddock	102.16	100.38
22	Flounder	102.19	100.32
45	Masquallonge	102.20	100.52
48	Sheepshead	102.33	100.65
30	Mackerel	102.37	100.61
39	Mackerel	102.39	100.87
18	Whitefish	102.87	100.87
271	Red grouper	102.94	100.62
3	Cod	103.02	100.52
259	Haddock	103.08	100.56
23	Smelt	103.09	100.62
257	Pike perch	103.23	100.62
253	Flounder	103.41	100.52
228	Cod	103.55	100.58
206	Rock cod	103.76	100.73
79	Desiccated cod	104.02	103.41
243	Cod	104.22	100.72
242	Red snapper	104.53	100.95
251	Sea bass	105.04	101.09
11	Cod	106.87	101.14
34	Salt cod	107.98	103.70
25	Salt cod	109.03	104.12
37	Desiccated salt cod	109.06	104.19
247	Skate	116.01	102.85

A more satisfactory way of getting at this matter is the usual one of dividing the total amount of nitrogenous matter by the amount of nitrogen and obtaining as quotient what may be termed the *nitrogen factor* of the protein, the amount of protein being simply the sum of the nitrogenous compounds, determined either directly, or, as in the present case, by difference. If the protein contains 16 per cent. of nitrogen the nitrogen factor is $100 \div 16 = 6.25$. If the percentage of nitrogen is larger, the nitrogen factor is smaller, and *vice versa*.

I have improved the occasion of analyzing the flesh of other animals referred to in the introduction to this article to compute the nitrogen factors for protein in those as well as in the fish. Some of the results are stated in the following table. Only the fresh (not the preserved) fish are included.

Nitrogen factors of protein in flesh of fish and other animals.

No. of specimens analyzed.	Kind of flesh.	Nitrogen factor.		
		Maximum.	Minimum.	Average.
	FLESH OF FISH.			
2	Land-locked salmon, spent (*Salmo salar* subsp. *sebago*)	6.51	6.40	6.45
2	Salmon, spent (*Salmo salar*)	6.32	6.28	6.30
1	Pollock (*Pollachius carbonarius*)			6.26
2	Yellow perch (*Perca fluviatilis*)	6.28	6.18	6.23
3	Porgy (*Stenotomus argyrops*)	6.25	6.20	6.23
1	Cusk (*Brosmius brosme*)			6.23
1	Lamprey eel (*Petromyzon marinus ?*)			6.23
1	Pickerel (*Esox lucius*)			6.23
2	Pickerel (*Esox reticulatus*)	6.24	6.20	6.22
1	Buffalo-fish (*Myxostoma celata*)			6.21
1	Cisco (*Argyrosomus tullibee*)			6.20
1	Hake (*Phycis chuss*)			6.20
1	Mullet (*Mugil albula*)			6.20
1	Pike perch (*Stizostedium vitreum*)			6.20
1	Alewife (*Pomolobus vernalis*)			6.19
2	Black bass (*Micropterus pallidus*)	6.19	6.19	6.19
1	Butter-fish (*Poronotus triacanthus*)			6.19
2	Pompano (*Trachynotus carolinus*)	6.20	6.18	6.19
1	Sturgeon (*Acipenser sturio*)			6.19
1	Tomcod (*Microgadus tomcodus*)			6.19
2	Eel (*Anguilla rostrata*)	6.20	6.15	6.18
1	Red bass (*Sciænops ocellatus*)			6.17
6	Striped bass (*Roccus lineatus*)	6.20	6.11	6.17
4	Blackfish (*Tautoga onitis*)	6.19	6.13	6.17
3	Halibut (*Hippoglossus americanus*)	6.24	6.12	6.17
2	White perch (*Morone americana*)	6.20	6.14	6.17
2	Smelt (*Osmerus mordax*)	6.31	6.02	6.17
1	King Fish (*Menticirrus nebulosus*)			6.16
7	Shad (*Alosa sapidissima*)	6.21	6.11	6.16
3	Brook trout (*Salvelinus fontinalis*)	6.19	6.13	6.16
3	Salmon (*Salmo salar*)	6.17	6.13	6.14
2	Salmon trout (*Cristivomer namaycush*)	6.15	6.14	6.14
2	Flounder (*Paralichthys dentatus*)	6.17	6.10	6.13
1	Mascalonge (*Esox nobilior*)			6.13
6	Mackerel (*Scomber scombrus*)	6.24	5.97	6.13
1	Weakfish (*Cynoscion regalis*)			6.13
1	Bluefish (*Pomatomus saltatrix*)			6.12
4	Haddock (*Melanogrammus æglefinus*)	6.19	6.05	6.12
2	Grouper (*Epinephelus morio*)	6.17	6.06	6.11
1	Spanish mackerel (*Cybium maculatum*)			6.11
2	Sheepshead (*Archosargus probatocephalus*)	6.11	6.05	6.08
2	Red snapper (*Lutjanus blackfordii*)	6.13	5.95	6.04
1	Herring (*Clupea harengus*)			6.04
1	Pike perch (*Stizostedium canadensis*)			6.03
1	Flounder (*Pseudopleuronectes americanus*)			6.02
1	Whitefish (*Coregonus clupeiformis*)			6.01
5	Cod (*Gadus morrhua*)	6.05	5.81	5.97
1	Skate (*Raia ——— ?*)			5.27
	Average, 47 species 96 specimens	6.51	5.27	6.14
	FLESH OF OTHER ANIMALS.			
28	Beef, flesh from different parts of body	6.41	6.02	6.21
8	Mutton, flesh from different parts of body	6.49	6.26	6.33
1	Pork			6.25
1	Turkey, white muscle } of same animal			6.22
1	Turkey, dark muscle }			5.78
1	Chicken, entire flesh of one animal			6.02

Were it not for the especial care observed in the analyses, of which more complete descriptions of methods and analytical details will, I trust, be given in a future report, I should be inclined to question the accuracy of some of the above figures for percentages of nitrogen. In every analysis the determinations were made in duplicate, and in a number where the results were out of the usual line, the determinations were

repeated. Thus, in the flesh of the skate, in which the nitrogen factor is the smallest of all, the two regular nitrogen determinations gave, respectively, 16.28 and 16.29 per cent. in the water-free flesh. These figures were so large that the analysis was repeated, with 16.30 per cent. as the result. It is worth noting that the flesh of a number of specimens of preserved fish gave results similar to those for the flesh of the fresh fish in the table. Thus a specimen of desiccated flesh of cod gave 5.98 as the nitrogen factor, a number identical with the average of the specimens of the fresh cod. The figures for the salted fish are, however, more variable, a circumstance which I am unable to explain.

The small nitrogen factors in the skate, cod and some other specimens are of no little interest. That of cod, 5.97, corresponds to 16.75 per cent. of nitrogen, and that of skate, 5.27, to 18.95 per cent. of nitrogen in the protein. These facts may point to decided peculiarities in the constituents of the flesh, particularly in the case of the skate.

RECAPITULATION OF THE ANALYSES OF FISH.

As the large Tables I to VI (at the end of this article) are somewhat bulky and inconvenient for perusal, I give some of the more important details of the percentages of nutritive and other ingredients of the specimens of fish, invertebrates, etc., in Tables VII and X which follow and will explain themselves. It will be borne in mind that the figures are computed from Table II, in which the protein is estimated by difference.

TABLE VII.—*Composition of flesh (edible portion, freed from bone, skin, shells, and other refuse) of food-fishes and invertebrates, etc., arranged in order, from those with the largest to those with the smallest percentages of nutrients.*

No. of specimens analyzed.	Kinds of food-fishes, invertebrates, etc.	Salt.	Water.	Water-free substance (nutrients).	Nutrients. Protein.	Fats.	Carbohydrates.	Mineral matters.
	FRESH FISH.							
3	Salmon (*Salmo salar*)	......	63.2	36.8	22.6	12.9	......	1.3
1	Spanish mackerel (*Cybium maculatum*)	......	68.1	31.9	21.0	9.1	......	1.5
1	Herring (*Clupea harengus*)	......	69.0	31.0	18.5	11.0	......	1.5
	Salmon trout, "Mackinaw trout" (*Cristiromer namaycush*).	......	69.1	30.9	18.3	11.3	......	1.3
1	Whitefish (*Coregonus clupeiformis*)	......	69.8	30.2	22.1	6.5	......	1.6
1	Butterfish (*Poronotus triacanthus*)	......	70.0	30.0	17.9	11.0	......	1.1
	Shad (*Alosa sapidissima*), very fat	......	65.2	34.8	19.7	13.6	......	1.5
	Shad (*Alosa sapidissima*), rather lean	......	72.0	28.0	20.0	6.5	......	1.5
7	Shad (*Alosa sapidissima*), average	......	70.6	29.4	18.6	9.5	......	1.3
1	Lamprey eel (*Petromyzon marinus*)	......	71.1	28.9	14.9	13.3	......	0.7
2	Eel, salt-water (*Anguilla rostrata*)	......	71.6	28.4	18.3	9.1	......	1.0
2	Pompano (*Trachynotus carolinus*)	......	72.8	27.2	18.7	7.5	......	1.0
1	Alewife (*Pomolobus vernalis*)	......	73.0	27.0	19.5	6.0	......	1.5
	Mackerel (*Scomber scombrus*), very fat	......	64.0	36.0	18.2	16.3	......	1.5
	Mackerel (*Scomber scombrus*), rather lean	......	75.4	24.6	19.1	4.2	......	1.3
6	Mackerel (*Scomber scombrus*), average	......	73.4	26.6	18.3	7.0	......	1.3
1	Mullet (*Mugil albula*)	......	74.9	25.1	19.3	4.6	......	1.2
3	Porgy (*Stenotomus argyrops*)	......	75.0	25.0	18.5	5.1	......	1.4
	Halibut (*Hippoglossus americanus*), very fat	......	70.1	29.9	18.2	10.6	......	1.1
	Halibut (*Hippoglossus americanus*), rather lean	......	79.2	20.8	17.5	2.2	......	1.1
3	Halibut (*Hippoglossus americanus*), average	......	75.4	24.6	18.3	5.2	......	1.1

TABLE VII.—*Composition of flesh of food-fishes, &c.*—Continued.

No. of specimens analyzed.	Kinds of food-fishes, invertebrates, etc.	Salt.	Water.	Water-free substance (nutrients).	Nutrients. Protein.	Fats.	Carbohydrates.	Mineral matters.
	FRESH FISH—Continued.							
2	Sheepshead (*Archosargus probatocephalus*)	......	75.5	24.5	19.6	3.7	......	1.2
2	White perch (*Morone americana*)	......	75.7	24.3	19.0	4.1	......	1.2
1	Pollock (*Pollachius carbonarius*)	......	76.0	24.0	21.7	0.8	......	1.5
1	Cisco (*Argyrosomus tullibee*)	......	76.1	23.9	19.1	3.5	......	1.3
1	Mascalonge (*Esox nobilior*)	......	76.3	23.7	19.6	2.5	......	1.6
2	Black bass (*Micropterus pallidus*)	......	76.7	23.3	20.4	1.7	......	1.2
6	Striped bass (*Roccus lineatus*)	......	77.7	22.3	18.3	2.8	......	1.2
3	Brook trout (*Salvelinus fontinalis*)	......	77.7	22.3	19.0	2.1	......	1.2
1	Bluefish (*Pomatomus saltatrix*)	......	78.5	21.5	19.0	1.2	......	1.3
1	Buffalo-fish (*Myxostoma celata*)	......	78.6	21.4	17.9	2.3	......	1.2
2	Red snapper (*Lutjanus blackfordii*)	......	78.6	21.4	18.8	1.2	......	1.3
1	Sturgeon (*Acipenser sturio*)	......	78.7	21.3	18.0	1.9	......	1.4
1	Weakfish (*Cynoscion regalis*)	......	79.0	21.0	17.4	2.4	......	1.2
4	Blackfish (*Tautoga onitis*)	......	79.1	20.9	18.5	1.3	......	1.1
2	Smelt (*Osmerus mordax*)	......	79.2	20.8	17.3	1.8	......	1.7
1	Kingfish (*Menticirrus nebulosus*)	......	79.2	20.8	18.6	1.0	......	1.2
2	Yellow perch (*Perca fluviatilis*)	......	79.2	20.8	18.8	0.8	......	1.2
1	Sea bass (*Centropristis atrarius*)	......	79.3	20.7	18.8	0.5	......	1.4
2	Grouper (*Epinephelus morio*)	......	79.4	20.6	18.8	0.6	......	1.2
2	Pickerel (*Esox reticulatus*)	......	79.7	20.3	18.6	0.5	......	1.2
1	Pike perch (*Stizostedium vitreum*)	......	79.7	20.3	18.4	0.5	......	1.4
1	Pickerel (*Esox lucius*)	......	79.8	20.2	18.6	0.6	......	1.0
1	Pike perch (*Stizostedium canadensis*)	......	80.9	19.1	17.2	0.8	......	1.1
1	Tomcod (*Microgadus tomcodus*)	......	81.5	18.5	17.1	0.4	......	1.0
1	Red bass (*Sciænops ocellatus*)	......	81.6	18.4	16.7	0.5	......	1.2
4	Haddock (*Melanogrammus æglefinus*)	......	81.7	18.3	16.8	0.3	......	1.2
1	Cusk (*Brosmius brosme*)	......	82.0	18.0	16.9	0.2	......	0.9
1	Skate (*Raia?*)	......	82.1	17.9	15.3	1.4	......	1.2
5	Cod (*Gadus morrhua*)	......	82.6	17.4	15.8	0.4	......	1.2
1	Hake (*Phycis chuss*)	......	83.1	16.9	15.2	0.7	......	1.0
2	Flounder (*Paralichthys dentatus*)	......	84.2	15.8	13.8	0.7	......	1.3
1	Flounder (*Pseudopleuronectes americanus*)	......	84.4	15.6	14.0	0.4	......	1.2
	ROE.							
1	Shad roe	......	71.2	28.8	23.5	3.8	......	1.5
	SPENT FISH.							
2	Salmon (*Salmo salar*)	......	76.7	23.3	18.6	3.6	......	1.1
2	Land-locked salmon (*Salmo salar* subsp. *sebago*)	......	78.5	21.5	17.3	3.0	......	1.2
	PRESERVED FISH.							
	Dried.							
1	Desiccated cod, dried flesh (*Gadus morrhua*)	2.9	15.3	81.8	74.5	1.9	......	5.4
	Salted.							
1	Salt mackerel (*Scomber scombrus*)	10.6	42.2	47.2	22.0	22.6	......	2.6
	Salted and dried.							
1	Desiccated cod, dried flesh (*Gadus morrhua*)	6.6	11.6	81.8	71.7	4.9	......	5.2
1	Cod, boned (*Gadus morrhua*)	19.1	54.4	26.5	22.1	0.3	......	4.1
2	Cod (*Gadus morrhua*)	20.6	53.6	25.8	21.4	0.3	......	4.1
	Salted, smoked, and dried.							
1	Herring (*Clupea harengus*)	11.7	34.5	53.8	36.5	15.8	......	1.5
2	Halibut (*Hippoglossus americanus*)	13.0	49.4	37.6	20.5	15.0	......	2.1
1	Haddock, "Findon haddie" (*Melanogrammus æglefinus*).	2.1	72.5	25.4	23.7	0.2	......	1.5
	Canned.							
1	Tunny, "Horse mackerel" (*Orcynus secundo-dorsalis?*).	9.5	43.2	47.3	16.9	27.9	......	2.5
2	Salt mackerel (*Scomber scombrus*)	10.3	43.4	46.3	17.3	26.4	......	2.6
1	Sardines (*Clupea pilchardus?*)	......	56.4	43.6	25.3	12.7	......	5.6

TABLE VII.—*Composition of flesh of food-fishes, &c.*—Continued.

No. of specimens analyzed.	Kinds of food-fishes, invertebrates, etc.	Salt.	Water.	Water-free substance (nutrients).	Nutrients. Protein.	Fats.	Carbohydrates.	Mineral matters.
	PRESERVED FISH—Continued.							
	Canned—Continued.							
3	Salmon (*Oncorhynchus chouicha*)	1.3	59.9	38.8	19.4	18.0	......	1.4
1	Mackerel (*Scomber scombrus*)	1.9	68.2	29.9	19.9	8.7	......	1.3
1	"Findon haddie," smoked haddock (*Melanogrammus æglefinus*).	5.6	68.7	25.7	21.7	2.3	......	1.7
	Shell-fish, &c.							
	Oysters (*Ostrea virginiana*), shell contents, poorest.[1]	......	91.5	8.5	4.5	0.6	1.7	1.7
	Oysters (*Ostrea virginiana*), shell contents, richest.[1]	......	85.3	14.7	6.2	1.3	5.0	2.2
34	Oysters (*Ostrea virginiana*), shell contents, average.[1]	......	87.3	12.7	6.0	1.2	3.5	2.0
4	Oysters (*Ostrea virginiana*), "solids"[2]	......	87.2	12.8	6.3	1.6	4.0	0.9
4	Long clams (*Mya arenaria*), shell contents	......	85.9	14.1	8.5	1.0	2.0	2.6
1	Round clams (*Venus mercenaria*), shell contents	......	86.2	13.8	6.6	0.4	4.2	2.6
1	Mussels (*Mytilus edulis*), shell contents	......	84.2	15.8	8.7	1.1	4.1	1.9
2	Scallops (*Pecten irradians*) edible portion (muscle)	......	80.3	19.7	14.7	0.2	3.4	1.4
4	Lobster (*Homarus americanus*), shell contents	......	81.8	18.2	14.7	1.8	0.0	1.7
1	Crabs (*Ballinectes hastatus*), shell contents	......	77.1	22.9	16.6	2.0	1.2	3.1
1	Crayfish, shell contents	......	81.2	18.8	16.0	0.5	1.0	1.3
1	Terrapin shell contents	......	74.5	25.5	21.0	3.5	......	1.0
1	Green turtle (*Chelonia mydas*), shell contents	......	79.8	20.2	18.5	0.5	......	1.2
	Canned.							
3	Oysters (*Ostrea virginiana*)	......	85.2	14.8	7.4	2.1	4.0	1.3
1	Long clams (*Mya arenaria*)	......	84.5	15.5	9.1	1.3	2.8	2.3
1	Round clams (*Venus mercenaria*)	......	82.9	17.1	9.6	0.7	3.1	3.7
2	Lobster (*Homarus americanus*)	......	77.8	22.2	18.0	1.1	0.6	2.5
2	Crabs (*Ballinectes hastatus*)	......	80.0	20.0	15.9	1.5	0.7	1.9

[1] In respect to percentage of nutrients, with no reference to flavor.
[2] Shell contents as commonly sold, including whole of flesh and part of liquids.

PROPORTIONS OF FLESH IN THE BODIES OF THE SPECIMENS OF FISH.

As was stated in the description of the methods of analysis, the specimens were received for analysis in the forms in which they are ordinarily sold in the markets—some whole, others dressed. They were weighed as received, and the flesh, thereupon, separated from the skin, bones and other organs as perfectly as could conveniently be done. The flesh and the refuse matter thus separated were each weighed and their percentages computed with results as set forth in Tables V and VIII. More or less of the flesh adhered to the skin and bones; but the quantities thus neglected were extremely small in proportion to the whole amount, and the figures in the tables are practically correct. The flesh, except in the fatter specimens, consisted mainly of muscular tissue. The proportions in the specimens of entire (not dressed) fish are recapitulated in Table VIII.

TABLE VIII.—*Percentages of flesh in specimens of entire fish, arranged in order from those with the highest to those with the lowest proportions of flesh.*

Kinds of fish.	No. of specimens analyzed.	Percentages of flesh. Maximum.	Minimum.	Average.
FRESH FISH.				
Spanish mackerel (*Cybium maculatum*)	1	....	....	65.4
Salmon (*Salmo salar*)	2	62.5	60.5	61.5
Smelt (*Osmerus mordax*)	2	65.2	51.0	58.1
Pickerel (*Esox lucius*)	1	....	....	57.3
Cisco (*Argyrosomus tullibee*)	1	....	....	57.3
Butter fish (*Poronotus triacanthus*)	1	....	....	57.2
Spent salmon (*Salmo salar*)	2	56.5	56.2	56.4
Mackerel (*Scomber scombrus*)	5	66.2	48.[illegible]	55.4
Pompano (*Trachynotus carolinus*)	2	57.6	51.4	54.5
Lamprey eel (*Petromyzon marinus?*)	1	....	....	54.2
Herring (*Clupea harengus*)	1	....	....	54.0
Pickerel (*Esox reticulatus*)	2	54.6	51.3	53.0
Spent land-locked salmon (*Salmo salar* subsp. *sebago*)	2	53.8	51.6	52.7
Brook trout (*Salvelinus fontinalis*)	3	54.8	49.9	51.9
Muscalonge (*Esox nobilior*)	1	....	....	50.8
Alewife (*Pomolobus vernalis*)	1	....	....	50.6
Shad (*Alosa sapidissima*)	7	55.6	41.2	49.9
Weakfish (*Cynoscion regalis*)	1	....	....	48.1
Cod (*Gadus morrhua*)	2	51.5	43.5	47.5
Whitefish (*Coregonus clupeiformis*)	1	....	....	46.5
Black bass (*Micropterus pallidus*)	2	46.4	44.0	45.2
Striped bass (*Roccus lineatus*)	5	51.4	42.9	45.1
Sea bass (*Centropristis atrarius*)	1	....	....	43.9
Flounder (*Pseudopleuronectes americanus*)	1	....	....	43.8
Salmon trout (*Cristivomer namaycush*)	1	....	....	43.7
Kingfish (*Menticirrus nebulosus*)	1	....	....	43.4
Pike perch (*Stizostedium vitreum*)	1	....	....	42.8
Mullet (*Mugil albula*)	1	....	....	42.1
Tomcod (*Microgadus tomcodus*)	1	....	....	40.1
Porgy (*Stenotomus argyrops*)	3	42.7	34.9	40.0
Blackfish (*Tautoga onitis*)	2	43.8	35.9	39.8
White perch (*Morone americana*)	2	38.2	36.8	37.5
Yellow perch (*Perca fluviatilis*)	1	....	....	37.3
Pike perch (*Stizostedium canadensis*)	1	....	....	36.8
Red bass (*Sciænops ocellatus*)	1	....	....	36.5
Sheepshead (*Archosargus probatocephalus*)	1	....	....	34.0
Flounder (*Paralichthys dentatus*)	1	....	....	33.2

Thus the largest percentage of flesh was in the Spanish mackerel, 65.4, and the smallest in the flounder, 33.2, per cent. I shall refer to these figures again.

The variations in the composition of the flesh are as wide as those of the amounts of flesh in the whole animal, as appears from Table IX, which follows:

TABLE IX.—*Percentage of water-free substance (nutrients) in flesh of fish, arranged in order from those with the highest to those with the lowest proportion of water-free substance.*

Kinds of fish.	No. of specimens analyzed.	Percentages of water-free substance in flesh. Maximum.	Minimum.	Average.
FRESH FISH.				
Salmon	3	38.97	32.85	36.82
Spanish mackerel	1	....	....	31.90
Herring	1	....	....	30.97
Salmon trout	2	31.22	30.50	30.86
Whitefish	1	....	....	30.17
Butter-fish	1	....	....	29.98
Shad	7	34.75	26.44	29.25

TABLE IX.—*Percentage of water-free substance, &c.*—Continued.

Kinds of fish.	No. of specimens analyzed.	Percentages of water-free substance in flesh. Maximum.	Minimum.	Average.
FRESH FISH—Continued.				
Lamprey eel	1			28.88
Eel, salt-water	2	30.20	26.60	28.40
Pompano	2	32.62	21.82	27.22
Alewife	1			27.04
Mackerel	6	35.99	21.33	26.63
Mullet	1			25.13
Porgy	3	28.62	20.32	25.01
Halibut	3	29.87	20.85	24.58
Sheepshead	2	27.99	20.92	24.15
White perch	2	24.36	24.23	24.29
Pollock	1			23.98
Cisco	1			23.85
Mascalonge	1			23.74
Black bass	2	25.18	21.39	23.29
Spent salmon	2	24.73	21.80	23.26
Striped bass	6	24.24	20.27	22.29
Brook trout	3	24.22	20.16	22.28
Bluefish	1			21.54
Spent land-locked salmon	2	22.12	20.80	21.46
Buffalo fish	1			21.11
Red snapper	2	22.66	20.19	21.42
Weakfish	1			21.03
Blackfish	4	23.05	18.64	20.90
Smelt	2	21.84	19.84	20.84
Kingfish	1			20.79
Yellow perch	2	21.93	19.57	20.75
Sea bass	1			20.68
Grouper	2	21.04	20.15	20.60
Pickerel	2	20.48	20.16	20.32
Pike perch	1			20.26
Pickerel	1			20.21
Pike perch	1			19.15
Tomcod	1			18.45
Red bass	1			18.44
Haddock	4	19.70	17.44	18.31
Cusk	1			17.99
Skate	1			17.85
Cod	5	19.29	16.52	17.36
Hake	1			16.89
Flounder	2	16.63	14.96	15.79
Flounder	1			15.65
ROE.				
Shad roe	1			28.75
PRESERVED FISH.				
Cod, boned, steam dried, and ground	1			81.87
Cod, boned, steam dried, and ground (salted)	1			81.87
Herring, salted, smoked, and dried	1			53.79
Tunny, "Horse mackerel," canned	1			47.33
Mackerel, salted	1			47.21
Mackerel, salted, canned	2	47.33	45.22	46.27
Sardines	1			43.63
Salmon, canned	3	42.04	33.61	38.81
Halibut, salted, smoked, and dried	2	39.43	35.89	37.66
Mackerel, canned	1			29.89
Cod, salted and dried (boned)	1			26.52
Cod, salted and dried	2	26.21	25.43	25.81
Canned "Findon haddie," smoked haddock	1			25.68
Haddock, "Findon haddie," salted, smoked, and dried	1			25.38

CLASSIFICATION OF FISH BY THEIR COMPOSITION.

On the basis of the figures of Tables VII, VIII, and IX, I have attempted a classification of the specimens of fish by their content of (1) flesh, (2) water-free substance in flesh, and (3) water and fats. With the following figures, the classifications will need no further explanation. Where more than one specimen was analyzed the averages of the

analyses are used. Of course a satisfactory classification would require many more analyses. Nevertheless these figures may be assumed to give a tolerably fair idea of the relative composition of the fish, or at least, an approximation that may serve until more complete data are obtained. Accordingly the order of the kinds in each of the four following groups must be regarded as by no means fixed, since further analyses would very likely give averages varying more or less from the results here tabulated.

CLASSIFICATION OF SPECIMENS OF FISH BY AMOUNTS OF FLESH (CHIEFLY MUSCULAR TISSUE) IN THE BODY, OR, IN OTHER WORDS, BY THE RATIO OF THE WEIGHT OF THE FLESH TO THE SUM OF WEIGHTS OF THE OTHER TISSUES.

SPECIMENS CONTAINING OVER 60 PER CENT. OF FLESH.

No. of specimens analyzed.	Kind of fish.	Flesh.	No. of specimens analyzed.	Kind of fish.	Flesh.
		Per cent.			Per cent.
1	Spanish mackerel	65.4	2	Salmon	61.5

SPECIMENS CONTAINING BETWEEN 60 AND 50 PER CENT. OF FLESH.

2	Smelt	58.1	1	Lamprey eel	54.2
1	Pickerel[1]	57.3	1	Herring	54.0
1	Cisco	57.3	2	Pickerel[2]	53.0
1	Butterfish	57.2	2	Spent land-locked salmon	52.7
2	Spent salmon	56.4	3	Brook trout	51.9
5	Mackerel	55.4	1	Mascalonge	50.8
2	Pompano	54.5	1	Alewife	50.6

SPECIMENS CONTAINING BETWEEN 50 AND 40 PER CENT., INCLUSIVE, OF FLESH.

7	Shad	49.9	1	Flounder[3]	43.8
1	Weakfish	48.1	1	Salmon trout	43.7
2	Cod	47.5	1	Kingfish	43.4
1	Whitefish	46.5	1	Pike perch[4]	42.8
2	Black bass	45.2	1	Mullet	42.1
5	Striped bass	45.1	1	Tom-cod	40.1
1	Sea bass	43.9	3	Porgy	40.0

SPECIMENS CONTAINING BETWEEN 40 AND 30 PER CENT. OF FLESH.

2	Blackfish	39.8	1	Red bass	36.5
2	White perch	37.5	1	Sheepshead	34.0
1	Yellow perch	37.3	1	Flounder[6]	33.2
1	Pike perch[5]	36.8			

[1] *Esox lucius.*
[2] *Esox reticulatus.*
[3] *Pseudopleuronectes americanus.*
[4] *Stizostedium vitreum.*
[5] *Stizostedium canadensis.*
[6] *Paralichthys dentatus.*

CLASSIFICATION OF SPECIMENS OF FISH BY AMOUNTS OF WATER-FREE SUBSTANCE IN THE FLESH.

The kinds of fish analyzed are grouped below on the basis of the percentages of water-free substance in the flesh. The specimens are ranged in order from those with the largest to those with the smallest amounts of water-free substance. Of course those with the most water-free substance have the least water, and vice versa. Hence, the first in this arrangement have the lowest percentages of water, while the last are the most watery.

SPECIMENS CONTAINING OVER 30 PER CENT. OF WATER-FREE SUBSTANCE.

No. of specimens analyzed.	Kind of fish.	Water-free.	No. of specimens analyzed.	Kind of fish.	Water-free.
		Per cent.			*Per cent.*
3	Maine salmon	36.8	1	Herring	31.0
1	California salmon [1]	35.5	2	Salmon trout	30.9
1	Spanish mackerel	31.9	1	Whitefish	30.2

SPECIMENS CONTAINING FROM 30 TO 25 PER CENT. OF WATER-FREE SUBSTANCE.

1	Butterfish	30.0	1	Alewife	27.0
7	Shad	29.4	6	Mackerel	26.6
1	Lamprey eel	28.9	1	Mullet	25.1
2	Eel, salt-water	28.4	3	Porgy	25.0
2	Pompano	27.2			

SPECIMENS CONTAINING BETWEEN 25 AND 20 PER CENT. OF WATER-FREE SUBSTANCE.

3	Halibut	24.6	2	Red snapper	21.4
2	Sheepshead	24.5	1	Sturgeon [1]	21.3
2	White perch	24.3	1	Weakfish	21.0
1	Pollock	24.0	4	Blackfish	20.9
1	Cisco	23.9	2	Smelt	20.8
1	Mascalonge	23.7	1	Kingfish	20.8
2	Black bass	23.3	2	Yellow perch	20.8
2	Spent salmon	23.3	1	Sea bass	20.7
6	Striped bass	22.3	2	Grouper	20.6
3	Brook trout	22.3	2	Pickerel [2]	20.3
1	Bluefish	21.5	1	Pike perch [3]	20.3
2	Spent land-locked salmon	21.5	1	Pickerel [4]	20.2
1	Buffalo fish	21.4			

SPECIMENS CONTAINING BETWEEN 20 AND 15 PER CENT. OF WATER-FREE SUBSTANCE.

1	Pike perch [5]	19.1	1	Skate	17.9
1	Tomcod	18.5	5	Cod	17.4
1	Red bass	18.4	1	Hake	16.9
4	Haddock	18.3	2	Flounder [6]	15.8
1	Cusk	18.0	1	Flounder [7]	15.6

[1] The specimen contained only a section of the body, and not the whole body or the whole of the edible portion of a fish, as was the case with the other specimens.
[2] *Esox reticulatus.*
[3] *Stizostedium vitreum.*
[4] *Esox lucius.*
[5] *Stizostedium canadensis.*
[6] *Paralichthys dentatus.*
[7] *Pseudopleuronectes americanus.*

PERCENTAGES OF FATS AND WATER IN FLESH OF SPECIMENS OF FISH OF DIFFERENT SPECIES.

It is interesting to observe the connection between the proportions of water and those of fat in the flesh of the fish. In the tissues of fish, as of other animals, as is well known, an increase of fat is generally accompanied by a decrease of water. This is strikingly the case in the flesh of the fish analyzed, as is shown in the following classification, in which the specimens are grouped on the basis of their percentages of fats (ether extract), in order commencing with the fattest and ending with the leanest specimens. Where more than one specimen was analyzed the average figures are given, as in the preceding classifications.

SPECIMENS CONTAINING OVER 5 PER CENT. OF FATS.

No. of specimens analyzed.	Kinds of fish.	Water.	Fats.	No. of specimens analyzed.	Kinds of fish.	Water.	Fats.
		Per cent.	*Per cent.*			*Per cent.*	*Per cent.*
1	Lamprey eel	71.1	13.3	2	Eel, salt-water	71.6	9.1
3	Salmon	63.2	12.9	2	Pompano	72.8	7.5
2	Salmon trout	69.1	11.3	6	Mackerel	73.4	7.0
1	Butter-fish	70.0	11.0	1	Whitefish	69.8	6.5
1	Herring	69.0	11.0	1	Alewife	73.0	6.0
7	Shad	70.6	9.5	3	Halibut	75.4	5.2
1	Spanish mackerel	68.1	9.4	2	Porgy	75.0	5.1

SPECIMENS CONTAINING BETWEEN 5 AND 2 PER CENT. OF FATS.

1	Mullet	74.9	4.6	1	Mascalonge	76.3	2.5
2	White perch	75.7	4.1	1	Weakfish	79.0	2.4
2	Sheepshead	75.5	3.7	1	Buffalo-fish	78.6	2.3
1	Cisco	76.2	3.5	3	Brook trout	77.7	2.1
6	Striped bass	77.7	2.8				

SPECIMENS CONTAINING LESS THAN 2, THE MAJORITY LESS THAN 1, PER CENT. OF FATS.

2	Smelt	79.[illegible]	1.8	2	Grouper	79.4	0.6
2	Black bass	76.7	1.7	1	Pickerel (3)	79.8	0.6
1	Skate	82.1	1.4	1	Sea bass	79.3	0.5
1	Blackfish	79.1	1.3	1	Pike perch (4)	79.7	0.5
1	Bluefish	78.5	1.2	2	Pickerel (5)	79.7	0.5
2	Red snapper	78.6	1.2	1	Red bass	81.6	0.5
1	Kingfish	[illegible]	1.0	1	Tomcod	81.5	0.4
1	Pollack	[illegible]	0.8	5	Cod	82.6	0.4
2	Yellow perch	79.5	0.8	1	Flounder (6)	84.3	0.[illegible]
1	Pike perch (1)	80.8	0.8	1	Haddock	81.7	0.3
1	Hake	83.1	0.7	1	Cusk	82.0	0.2
2	Flounder (2)	84.2	0.7				

[1] *Stizostedium canadensis.*
[2] *Paralichthys dentatus.*
[3] *Esox lucius.*
[4] *Stizostedium vitreum.*
[5] *Esox reticulatus.*
[6] *Pseudopleuronectes americanus.*

From these figures the general decrease of the water with the increase of fat is very apparent, though not perfectly regular. This might seem to be due simply to replacement of the water by fat in the tissues. It will be worth while to inquire whether this assumption is borne out by the analyses. To answer this question we should compare different

analyses of flesh of the same species, and see in how far the principle holds good, in other words, whether the protein remains constant, or nearly so, and whether the fat increases at the expense of the water or the water at the expense of the fat.

The following figures include all the cases in which two or more analyses were made of flesh containing in any case over 3 per cent of fats:

Percentages of fats, water, and protein in flesh of fish, different specimens of same species.

Kind of fish.	Number.	Fats.	Water.	Protein.
		Per cent.	*Per cent.*	*Per cent.*
Salmon (*Salmo salar*)	*280	13.1	61.0	24.5
	†279	13.0	61.4	24.2
	14	12.5	67.1	19.2
Spent salmon	*35	4.4	75.3	19.2
	†36	2.8	78.2	17.8
Salmon trout (*Cristivomer namaycush*)	17	12.5	68.8	17.3
	255	10.2	69.5	19.1
Shad (*Alosa sapidissima*)	10	13.6	65.3	19.7
	6	10.8	69.7	18.3
	212	10.2	71.0	17.8
	32	10.1	70.7	17.8
	245	8.1	72.1	18.2
	249	7.0	73.6	18.0
	221	6.5	72.0	20.0
Eel, salt-water (*Anguilla rostrata*)	4	10.3	69.8	18.9
	217	7.9	73.4	17.6
Pompano (*Trachynotus carolinus*)	234	13.5	67.4	18.1
	263	1.6	78.2	19.2
Mackerel (*Scomber scombrus*)	39	16.3	64.0	18.2
	13	7.0	74.3	17.5
	30	6.9	74.1	17.4
	230	5.9	73.7	19.2
	261	4.2	75.4	19.1
	8	2.2	78.7	18.1
Halibut (*Hippoglossus americanus*)	9	10.6	70.1	18.2
	211	2.8	77.0	19.4
	1	2.2	79.2	17.5
Porgy (*Stenotomus argyrops*)	31	7.9	72.0	18.8
	262	6.0	73.3	19.3
	15	1.5	79.7	17.5
White perch (*Morone americana*)	44	5.6	75.6	17.6
	46	2.5	75.8	20.4
Sheepshead (*Archosargus probatocephalus*)	48	6.7	72.0	20.2
	250	0.7	79.1	18.9
Striped bass (*Roccus lineatus*)	260	4.6	76.6	17.8
	237	3.6	75.8	19.3
	225	2.8	77.3	18.8
	248	2.2	77.9	18.8
	19	2.2	79.7	16.7
	7	1.6	79.0	18.3

*Male. †Female.

In this juxtaposition of the figures, the very regular increase of water with decrease of fat in the flesh is striking. It is also very noticeable that, except in the case of the salmon, the percentage of protein in each species remains nearly constant while the percentages of fats rise as those of water fall and *vice versa*. In other words, the protein remains practically constant, while as fat is stored in the flesh water is driven out, and as the fat is removed water takes its place. The physiological bearing of this, I do not feel competent to discuss, if indeed it means anything more than simply that the fat and water mutually replace each other, volume for volume, in the flesh. If it be true, as I have seen it stated, that the fat globules are stored both without and within the muscular fibers, and that a considerable quantity may

be thus stored or removed without materially changing the volume of the tissue, the above simple explanation would, to one ignorant of histology, seem very natural.

I have been struck by this mutual replacement of fat and water in looking through a column of analyses of the flesh of fish and of other animals. In a colored diagram it is especially striking, though it is very well brought out in Table XI. If we leave out, on the one hand, a few of the most watery sorts of fish, as flounder, and, on the other, some of the fattest flesh of mammals, we have in the remaining fish and in the flesh of animals, an almost uniform content of protein, the chief variations being in the fat and the water, of which one increases as the other decreases, and *vice versa.*

CLASSIFICATION OF SPECIMENS OF FISH ON THE BASIS OF THE AMOUNTS OF FAT IN THE FLESH.

On the whole, perhaps, as appropriate a general classification as any for our present purpose would be based upon the proportions of fat in the flesh. The subjoined grouping, for instance, seems to be a tolerably satisfactory one.

1. Very fat fish; flesh containing over 10 per cent. of fat.
2. Moderately fat fish; flesh containing between 5 and 10 per cent. of fat.
3. Rather lean fish; flesh containing between 2 and 5 per cent. of fat.
4. Very lean fish, flesh containing less than 2 per cent. of fat.

I append a list of the specimens coming within each of the above categories, giving their approximate composition.

1. *Fish whose flesh contained over* 10 *per cent. of fat* (*very fat*).—Lamprey eel,* salmon, salmon trout, butter fish, herring. Composition of flesh: Water, 69 to 71 per cent.; water-free substance (nutrients), 30 to 37 per cent.; protein 18 to 23 per cent.; fats, 11 to 13 per cent.; mineral matters, 1.1 to 1.5 per cent.

2. *Fish whose flesh contained between* 10 *and* 5 *per cent. of fat* (*moderately fat*).—Shad, Spanish mackerel, eel, pompano, mackerel, whitefish, alewife, halibut, porgy. Composition of flesh: Water, 68 to 75 per cent.; water-free substance (nutrients), 25 to 32 per cent.; protein, 18 to 22 per cent.; fats, 5 to 10 per cent.; mineral matters, 1.0 to 1.6 per cent.

3. *Fish whose flesh contained between* 5 *and* 2 *per cent. of fat* (*rather lean*).—Mullet, white perch, sheepshead, cisco, striped bass, mascalonge, weakfish, buffalo-fish, brook trout. Composition of flesh: Water, 75 to 79, average, 77 per cent.; water-free substance (nutrients), 21 to 25, average, 23 per cent.; protein, 17 to 20, average, 19 per cent.; fats, 2 to 5, average, 3 per cent.; mineral matters, 1.2 to 1.6, average, 1.3 per cent.

*The composition of the specimen of lamprey eel was somewhat anomalous, having only 15 per cent. of protein and 0.7 per cent. of ash.

4. *Fish whose flesh contained less than 2 per cent. of fat (very lean).*—Smelt, red snapper, pike perch,[1] pickerel,[2] cod, kingfish, hake, sea bass, flounder,[3] skate, pollock, flounder, red bass, haddock, blackfish, yellow perch, grouper, tomcod, cusk. Composition of flesh: Water, 76 to 84 per cent.; water-free substance (nutrients), 16 to 24 per cent; protein, 14 to 22 per cent.; fats, 0 to 2 per cent.; ash, 0.9 to 1.7 per cent.

"FOUL" OR "SPENT" FISH *vs.* THOSE IN GOOD CONDITION.

The figures for salmon are very interesting in this connection. Nos. 279 and 280 were Penobscot River salmon in nearly their best condition. Nos. 35 and 36 were from the same source, but "spent," *i. e.*, taken just after spawning. The spent fish had not only less fat, but less protein than the fat fish, the spent fish averaging 18, and the fat fish, 24.2 per cent. of protein. How generally such differences would obtain, I cannot say. The fact that No. 14, which was also said to be from Maine (though whether it was from the Penobscot or not was not stated), had only 19 per cent. of protein, about the same as the spent salmon, would imply that the difference between the protein of the fat and the spent fish may not always be as great as in these specimens from the Penobscot. Nevertheless the difference is very striking. The very elaborate research of Professor Miescher upon the Rhine salmon[4] has many interesting facts bearing upon this subject, but no analyses exactly comparable with those above cited. The four specimens of Penobscot salmon, two taken in season and fat and two just after spawning and "spent," were furnished through the courtesy of Mr. Charles G. Atkins, of Bucksport, from the Government hatcheries, for the especial purpose of comparing their composition. The analyses from Tables III and V (those of whole fish from a table not given in this article) are as follows:

Composition of flesh of fat and spent salmon.

Laboratory number.	Salmon.	Water.	Water-free substance.	In water-free substance.		
				Protein.	Fats.	Ash.
	IN SEASON (fat).	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
280	Male	61.0	39.0	24.4	13.1	1.5
279	Female	61.4	38.6	24.2	13.0	1.4
	Average	61.2	38.8	24.3	13.1	1.4
	"SPENT."					
34	Male	75.3	24.7	19.2	4.4	1.1
35	Female	78.2	21.8	17.8	2.8	1.2
	Average	76.8	23.2	18.5	3.6	1.1

[1] Both *S. vitr.* and *S. can.* [2] Both *E. luc.* and *E. ret.*

[3] Both *Pseudopl. am.* and *Paral. dent.*

[4] *Zur Lebensgeschichte des Rheinlachses im Rhein. (Aus der schweizerischen Litteratursammlung zur internationalen Fischerei-Ausstellung in Berlin.)* Translated and reprinted in the Report of the U. S. Fish Commission of Fish and Fisheries, for 1880.

Composition of fat and spent salmon, whole fish.

Salmon.	Entrails, bones, skin, &c.	Flesh.	In flesh.				
			Water.	Water-free substance.	In water-free substance.		
					Protein.	Fats.	Ash.
FAT.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Male	39.5	60.5	36.9	23.6	14.8	7.9	0.9
Female	37.5	62.5	38.3	24.2	15.2	8.1	0.9
Average	38.5	61.5	37.6	23.9	15.0	8.0	0.9
"SPENT."							
Male	43.8	56.2	42.3	13.9	10.8	2.5	0.6
Female	43.5	56.5	44.2	12.3	10.0	1.6	0.7
Average	43.6	56.4	43.2	13.1	10.4	2.0	0.7

Recapitulation. Percentages of flesh, water-free substance, and nutrients in fat and spent salmon.

Salmon.	Flesh, edible portion.	Water-free substance in flesh.	In water-free substance.		
			Protein.	Fats.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
In flesh:					
Fat	100.0	38.8	24.3	13.1	1.4
Spent	100.0	23.2	18.5	3.6	1.1
In whole fish:					
Fat	61.5	23.9	15.0	8.0	0.9
Spent	56.4	13.1	10.4	2.0	0.7

In the above statements the protein is estimated by difference, as explained in the description of methods of analysis, and, the discussion of the nitrogen factors of the protein. Some differences in the composition of the nitrogenous constituents of the flesh are brought out by the following figures, which will be made clear by reference to the discussion of the nitrogen factors referred to.

The figures show (1) the percentages of protein as estimated by multiplying the nitrogen by 6.25; (2) the sum of the percentages of protein thus estimated + fats + ash + water; (3) the percentage of protein as computed by subtracting the sum of water + fats + ash from 100, "protein by difference"; (4) the nitrogen in the flesh, and (5) the "nitrogen factors," obtained by dividing the percentage of "protein by difference" by the nitrogen.

In flesh of salmon.	Fat.	Spent.
(1) Protein, N × 6.25 ... per cent..	24.7	18.4
(2) Protein, N × 6.25, + fat + ash + water ... do....	100.4	99.8
(3) Protein by difference ... do....	24.3	18.5
(4) Nitrogen in (3) ... do....	3.9	2.9
(5) Nitrogen factor ...	6.16	6.38

Professor Miescher has shown that in the Rhine salmon the development of the reproductive organs is done entirely at the expense of the other organs and tissues, or, to be more specific, at the expense of the albuminoids and fats of the flesh; the fish taking no food during its so-

journ in the fresh water, which sojourn includes the period in which the eggs and milt are developed. The natural result is a very large loss of both fat and albuminoids from the body. We have here an exaggerated case of leanness, one in which there is not only a decrease of fat, but of protein also, and the latter in large quantity.

We thus find in the spent salmon (1) a loss of flesh, so that the flesh of the spent salmon makes up but 56 per cent. of the whole weight of the body, while that of the fat salmon is 62 per cent.; (2) a loss of both fat and protein of the flesh, so that the flesh which remains in the spent fish contains only 23 per cent. of water-free substance against 38 per cent. in the fat flesh. The water-free substance of the flesh makes only 13 per cent. of the total weight of the spent, while it amounts to 24 per cent. of the fat, fish. Not only does the whole body lose weight from the fat to the spent condition, but the lighter spent fish contains pound for pound only about half as much nutritive material as the fat fish. The deterioration of the nutritive value of the flesh in the reproductive season is, if possible, greater than that of the flavor. The bearing of this upon legislation against the capture of the spent fish is very evident.

COMPOSITION AND RELATIVE NUTRITIVE VALUES OF FISH AS COMMONLY SOLD.

As already stated, the specimens were received for analysis in the forms in which they are commonly sold in the markets, some entire, others dressed. The condition of each in this respect is stated in Table IV, which gives the percentage of edible portion—flesh; and of refuse—bones, skin, entrails, &c. I have included the skin with the refuse, rather than with the edible portion, partly because it seemed best to analyze simply the flesh, and partly because the skin, though it generally contains more or less of nutritive material, is not usually eaten in this country, so far as I have observed. Of course it is eminently desirable from the chemical standpoint to know more than we do of the composition of the skin as of the other organs, and the time will doubtless come when increase of population will bring the need of such closer economizing of food material as will lead the people of this country to eat the skin of the fish that come on their tables, thus following the example of the inhabitants of older countries, where rigid economy of food, as of other necessaries of life, has long been necessary. Accordingly, in future analyses of fish for determining their economic value, the analyses of the skin will doubtless be desirable, and I do not question that such determinations would have added much to the value of the work reported. With the resources at my command, however, I did not feel myself warranted in undertaking them.

In Table X, I have recapitulated the composition of the specimens of fish as received for analysis, assuming them to represent the composition as ordinarily sold. Here, as previously, the protein is computed on the basis of Table I, *i. e.*, by difference.

Table X hardly needs explanation after all that has been said above. The arrangement of the specimens in the order of their amounts of actual nutrients is correct for these particular specimens, but, as was said regarding the previous tables, analyses of a larger number of specimens of each kind might give averages considerably different from the figures here.

The same remarks apply to the classification beyond which is based upon the amounts of nutrients in Table X.

Further remarks upon the comparative nutritive values of fish, invertebrates, and other food materials may be found beyond.

TABLE X.—*Percentages of refuse, water, and nutritive ingredients in specimens of American food-fishes, invertebrates, &c., as found in the markets.*

[Arranged in order, from those with the largest to those with the smallest proportion of nutrients.]

Number of specimens analyzed.	Kinds of fish, invertebrates, &c., and portions taken for analyses.	Salt.	Refuse—bone, skin, shells, &c.	Edible portion—flesh.	Edible portion.					
					Water.	Nutrients.	Nutrients			
							Protein.	Fats.	Carbo-hydrates.	Mineral matters.
	FRESH FISH.									
1	California salmon, section of body	......	10.3	89.7	57.9	31.8	16.1	14.8	......	0.9
1	Salmon, entrails removed	......	23.8	76.2	51.2	25.0	14.6	9.5	......	0.9
2	Salmon, whole	......	38.5	61.5	37.6	23.9	15.0	8.0	......	0.9
2	Eel, skin, head, and entrails removed	......	20.2	79.8	57.1	22.7	14.6	7.3	......	0.8
1	Spanish mackerel, whole	......	34.6	65.4	44.5	20.9	13.7	6.2	......	1.0
	Halibut, sections of body, very fat	......	11.2	88.8	62.3	26.5	16.1	9.4	......	1.0
	Halibut, sections of body, rather lean	......	18.7	81.3	62.6	18.7	15.8	2.2	......	0.7
3	Halibut, sections of body, average	......	17.7	82.3	61.2	20.2	15.1	4.2	......	0.9
1	Salmon trout, entrails removed	......	35.2	64.8	45.0	19.8	12.4	6.6	......	0.8
1	Sturgeon, sections of body	......	14.4	85.6	67.4	18.2	15.4	1.6	......	1.2
1	Pollock, head and entrails removed	......	28.5	71.5	54.3	17.2	15.5	0.6	......	1.1
1	Butter-fish, whole	......	42.8	57.2	40.1	17.1	10.2	6.3	......	0.6
1	Herring, whole	......	46.0	54.0	37.3	16.7	10.0	5.9	......	0.8
1	Lamprey eel, whole	......	45.8	54.2	38.5	15.7	8.1	7.2	......	0.4
1	Mackerel, entrails removed	......	40.7	59.3	43.7	15.6	11.4	3.5	......	0.7
2	Pompano, whole	......	45.5	54.5	39.5	15.0	10.2	4.3	......	0.5
	Mackerel, whole, very fat	......	33.8	66.2	42.4	23.8	12.1	10.7	......	1.0
	Mackerel, whole, rather lean	......	50.4	49.6	37.4	12.2	9.5	2.1	......	0.6
5	Mackerel, whole, average	......	44.6	55.4	40.7	14.7	10.1	3.9	......	0.7
	Shad, whole, very fat	......	46.4	53.6	35.0	18.6	10.5	7.3	......	0.8
	Shad, whole, lean	......	58.8	41.2	30.3	10.9	7.4	2.9	......	0.6
7	Shad, whole, average	......	50.1	49.9	35.2	14.7	9.3	4.7	......	0.7
1	Yellow perch, entrails removed	......	35.1	64.9	50.7	14.2	12.6	0.7	......	0.9
1	Whitefish, whole	......	53.5	46.5	32.5	14.0	10.3	3.0	......	0.7
1	Salmon trout, whole	......	56.3	43.7	30.0	13.7	7.7	5.4	......	0.6
1	Alewife, whole	......	49.4	50.6	36.9	13.7	9.9	3.0	......	0.8
1	Cisco, whole	......	42.7	57.3	43.6	13.7	11.0	2.0	......	0.7
1	Sheepshead, entrails removed	......	56.5	43.5	31.3	12.2	8.8	2.9	......	0.5
3	Cod, head and entrails removed	......	29.9	70.1	57.9	12.2	11.0	0.3	......	0.9
1	Mascalonge, whole	......	49.2	50.8	38.7	12.1	10.0	1.3	......	0.8
2	Smelt, whole	......	41.9	58.1	46.1	12.0	10.0	1.0	......	1.0
1	Pickerel,[1] whole	......	42.7	57.3	45.7	11.6	10.7	0.3	......	0.6
3	Brook trout, whole	......	48.1	51.9	40.3	11.6	9.9	1.1	......	0.6
1	Striped bass, entrails removed	......	51.2	48.8	37.4	11.4	8.7	2.2	......	0.5
1	Bluefish, entrails removed	......	48.6	51.4	40.3	11.1	9.8	0.6	......	0.7
2	Pickerel,[2] whole	......	47.0	53.0	42.2	10.8	9.9	0.2	......	0.7
2	Red snapper, entrails removed	......	48.9	51.1	40.3	10.8	9.6	0.6	......	0.6
1	Cusk, entrails removed	......	40.3	59.7	49.0	10.7	10.1	0.1	......	0.5
1	Mullet, whole	......	57.9	42.1	31.5	10.6	8.1	2.0	......	0.5
2	Black bass, whole	......	54.8	45.2	34.6	10.6	9.2	0.8	......	0.6
1	Buffalo-fish, entrails removed	......	52.5	47.5	37.3	10.2	8.5	1.1	......	0.6
1	Weakfish, whole	......	51.9	48.1	38.0	10.1	8.4	1.1	......	0.6
3	Porgy, whole	......	60.0	40.0	30.0	10.0	7.4	2.0	......	0.6
5	Striped bass, whole	......	54.9	45.1	35.1	10.0	8.3	1.3	......	0.4
2	Blackfish, entrails removed	......	55.7	44.3	35.0	9.3	8.2	0.6	......	0.5
2	White perch, whole	......	62.5	37.5	28.3	9.2	7.2	1.5	......	0.5
1	Sea bass, whole	......	56.1	43.9	34.8	9.1	8.3	0.2	......	0.6

[1] *Esox reticulatus.* [2] *E. lucius.*

TABLE X.— *Percentages of refuse, water, and nutritive ingredients, &c.*—Continued.

Number of specimens analyzed.	Kinds of fish, invertebrates, &c., and portions taken for analyses.	Salt.	Refuse—bone, skin, shells, &c.	Edible portion—flesh.	Edible portion.					
					Water.	Nutrients.	Nutrients.			
							Protein.	Fats.	Carbo-hydrates.	Mineral matters.
	FRESH FISH—Continued.									
2	Red grouper, entrails removed	......	55.8	44.2	35.1	9.1	8.3	0.3	......	0.5
1	Kingfish, whole	......	56.6	43.4	34.4	9.0	8.1	0.4	......	0.5
4	Haddock, entrails removed	......	51.0	49.0	40.0	9.0	8.3	0.1	......	0.6
1	Skate, left lobe of body	......	51.0	49.0	40.2	8.8	7.5	0.7	......	0.6
2	Cod, whole	......	52.5	47.5	38.7	8.8	8.0	0.2	......	0.6
1	Pike perch,[1] whole	......	57.2	42.8	34.1	8.7	7.9	0.2	......	0.6
2	Blackfish, whole	......	60.2	39.8	31.5	8.3	7.4	0.5	......	0.4
1	Hake, entrails removed	......	52.5	47.5	39.5	8.0	7.2	0.3	......	0.5
1	Tomcod, whole	......	59.9	40.1	32.7	7.4	6.8	0.2	......	0.4
1	Yellow perch, whole	......	62.7	37.3	30.0	7.3	6.7	0.2	......	0.4
1	Flounder,[2] entrails removed	......	57.0	43.0	35.8	7.2	6.3	0.3	......	0.6
1	Pike perch,[3] whole	......	63.2	36.8	29.7	7.1	6.4	0.3	......	0.4
1	Sheepshead, whole	......	66.0	34.0	26.9	7.1	6.4	0.2	......	0.5
1	Flounder,[4] whole	......	56.2	43.8	37.0	6.8	6.1	0.2	......	0.5
1	Red bass, whole	......	63.5	36.5	29.8	6.7	6.1	0.2	......	0.4
1	Flounder,[2] whole	......	66.8	33.2	27.2	6.0	5.2	0.3	......	0.5
	SPENT FISH.									
2	Salmon, whole	......	43.6	56.4	43.3	13.1	10.4	2.1	......	0.6
2	Land-locked salmon, whole	......	47.3	52.7	41.4	11.3	9.1	1.6	......	0.6
	PRESERVED FISH.									
	Dried.									
1	Desiccated cod (dried flesh)	2.9	0.0	97.1	15.2	81.9	74.6	1.9	......	5.4
	Salted									
1	Salted mackerel	8.2	22.9	68.9	32.5	36.4	17.0	17.4	......	2.0
	Salted and dried.									
1	Boned cod (salted flesh)	19.1	0.0	80.9	54.4	26.5	22.1	0.3	......	4.1
2	Salt cod (common "salt codfish")	15.4	24.9	5.97	40.3	19.4	16.0	0.4	......	3.0
	SALTED, SMOKED, AND DRIED.									
2	Smoked halibut	12.0	7.0	81.0	45.9	35.1	19.2	14.0	......	1.9
1	Smoked herring	6.5	44.4	49.1	19.2	29.9	20.2	8.8	......	0.9
1	Smoked haddock, "Findon haddie"	1.4	32.2	66.4	49.2	17.2	16.1	0.1	......	1.0
	Canned.									
1	Sardines	0.0	5.0	95.0	53.6	41.4	24.0	12.1	......	5.3
2	Salmon	1.0	3.9	95.1	59.3	35.8	19.3	15.3	......	1.2
2	Salt mackerel	8.3	19.7	72.0	34.8	37.2	13.8	21.3	......	2.1
1	Mackerel	1.9	0.0	98.1	68.2	29.9	19.9	8.7	......	1.3
1	Tunny, "horse mackerel"	0.0	0.0	100.0	72.7	27.3	21.5	4.1	......	1.7
1	"Findon haddie," smoked haddock	5.6	0.0	94.4	68.7	25.7	21.8	2.3	......	1.6
	SHELL FISH, ETC.									
	Oysters, in shell, poorest[5]	....	88.8	11.2	10.2	1.0	0.5	0.1	0.2	0.2
	Oysters, in shell, richest[5]	......	75.7	24.3	20.7	3.6	1.6	0.3	1.2	0.5
34	Oysters, in shell, average[5]	......	82.3	17.7	15.4	2.2	1.0	0.2	0.6	0.4
4	Oysters, "solids"[6]	......	0.0	100.0	87.2	12.8	6.3	1.6	4.0	0.9
4	Long clams, in shell	......	43.6	56.4	48.5	8.0	4.8	0.6	1.1	1.5
1	Round clams, in shell	......	68.3	31.7	27.3	4.4	2.1	0.1	1.3	0.9
1	Mussels, in shell	......	49.3	50.7	42.7	8.0	4.4	0.6	2.1	0.9
2	Scallops, edible portion	......	0.0	100.0	80.3	19.7	14.7	0.2	3.4	1.4
4	Lobsters, in shell	....	60.2	39.8	32.5	7.2	5.8	0.7	0.0	0.7
1	Crabs, in shell	......	55.8	44.2	34.0	10.1	7.3	0.9	0.5	1.4
1	Crayfish, in shell	......	87.7	12.3	10.0	2.3	1.9	0.1	0.1	0.2
1	Terrapin, in shell	...	79.0	21.0	15.6	5.3	4.4	0.7	......	0.2
1	Green turtle, in shell	......	76.0	24.0	19.2	4.8	4.4	0.1	......	0.3
	Canned.									
3	Oysters	......	0.0	100.0	85.2	14.8	7.4	2.1	4.0	1.3
1	Long clams	......	0.0	100.0	84.5	15.5	9.1	1.3	2.8	2.3
1	Round clams	......	0.0	100.0	82.9	17.1	9.6	0.7	3.1	3.7
2	Lobster	......	0.0	100.0	77.8	22.2	18.0	[illegible].1	0.6	2.5
2	Crabs	......	0.0	100.0	80.0	20.0	15.9	1.5	0.7	1.9

[1] *Stizostedium vitreum.* [2] *Paralicthys dentatus.* [3] *S. canadensis.* [4] *Pseudopleuronectes americanus.*
[5] In respect to percentage of nutrients, with no respect to flavor.
[6] Shell contents as commonly sold, including all of the flesh and part of the liquids

CLASSIFICATION OF FISH, FRESH AND PRESERVED, AS FOUND IN THE MARKETS, ON BASIS OF PERCENTAGES OF ACTUAL NUTRIENTS.

Specimens containing over 30 per cent. of nutrients (protein, fat, and mineral matters).

No. of specimens analyzed.	Kind of fish.	Nutrients.	No. of specimens analyzed.	Kind of fish.	Nutrients.
		Per cent.			Per cent.
1	Desiccated cod[1]	81.9	1	Salt mackerel	36.4
1	Canned sardines	41.4	2	Smoked halibut	35.1
2	Canned salmon	38.8	1	California salmon, sections of body	31.8
2	Canned salt mackerel	37.2			

Specimens containing between 30 and 20 per cent. of nutrients (water-free substance).

1	Smoked herring	29.9	2	Salmon, whole	23.9
1	Canned mackerel	29.9	2	Eel, skin, head, and entrails removed.	22.7
1	Canned tunny	27.3	1	Spanish mackerel, whole	20.9
1	Boned salt cod[2]	26.5	3	Halibut, sections of body	20.2
1	Canned smoked haddock	25.7			
1	Salmon, entrails removed	25.0			

Specimens containing between 20 and 10 per cent. of nutrients.

1	Salmon trout, entrails removed	19.8	1	Sheepshead, entrails removed	12.2
2	Salt cod[3]	19.4	3	Cod, head and entrails removed	12.2
1	Sturgeon, sections of body	18.2	1	Mascalonge, whole	12.1
1	Pollock, head and entrails removed	17.2	2	Smelt, whole	12.0
1	Smoked haddock	17.2	1	Pickerel,[4] whole	11.6
1	Butter-fish, whole	17.1	3	Brook trout, whole	11.6
1	Herring, whole	16.7	1	Striped bass, entrails removed	11.4
1	Lamprey eel, whole	15.7	2	Spent land-locked salmon, whole	11.3
1	Mackerel, entrails removed	15.6	1	Bluefish, entrails removed	11.1
2	Pompano, whole	15.0	2	Pickerel,[5] whole	10.8
5	Mackerel, whole	14.7	2	Red snapper, entrails removed	10.8
7	Shad, whole	14.7	1	Cusk, entrails removed	10.7
1	Yellow perch, entrails removed	14.2	1	Mullet, whole	10.6
1	Whitefish, whole	14.0	2	Black bass, whole	10.6
1	Salmon trout, whole	13.7	1	Buffalo-fish, entrails removed	10.2
1	Alewife, whole	13.7	1	Weakfish, whole	10.1
1	Cisco, whole	13.7	3	Porgy, whole	10.0
2	Spent salmon, whole	13.1	5	Striped bass	10.0

Specimens containing less than 10 per cent. of nutrients.

2	Blackfish, entrails removed	9.3	1	Hake, entrails removed	8.0
2	White perch, whole	9.2	1	Tomcod, whole	7.4
1	Sea bass, whole	9.1	1	Yellow perch, whole	7.3
2	Red grouper, entrails removed	9.1	1	Flounder, entrails removed	7.2
1	Kingfish, whole	9.0	1	Pike perch,[7] whole	7.1
4	Haddock, entrails removed	9.0	1	Sheepshead, whole	7.1
1	Skate, left lobe of body	8.8	1	Flounder,[8] whole	6.8
2	Cod, whole	8.8	1	Red bass, whole	6.7
1	Pike perch,[6] whole	8.7	1	Flounder,[9] whole	6.0
2	Blackfish, whole	8.3			

[1] Flesh freed from bones and artificially dried. [2] The flesh of ordinary salt codfish. [3] Ordinary "salt codfish." [4] *E. luc.* [5] *E. ret.* [6] *S. vit.* [7] *S. canad.* [8] *Ps. am.* [9] *Par. dent.*

ECONOMIC APPLICATION OF THE RESULTS OF THE ANALYSES*

In estimating their nutritive values, the constituents of our ordinary food materials may be succinctly classified as follows:

1. *Edible substance: e. g.*, the flesh of meats and fish, the shell contents of oysters.

* The following explanations regarding the nutritive values of fish and other food-materials are adapted, by request, from statements prepared for the food collection of the National Museum.

2. *Refuse: e. g.*, bones of meat and fish, shells of oysters.

The edible substance consists of—

1. *Water.* 2. *Nutritive substances or nutrients.*—The refuse may, for our present purpose, be left out of account, and our attention confined to the edible substance. And, as the water which forms a part of the edible substance, though indispensable, is nevertheless inexpensive and distinct from the nutritive ingredients, we may consider simply the nutrients.

Speaking as chemists and physiologists, we may say that our food supplies, besides mineral substances and water, albuminoids, carbo-hydrates, and fats; and that these are transformed into the tissues and fluids of the body, muscle and fat, blood and bone, and are consumed to produce heat and force. Viewed from a chemico-physiological standpoint, then, the nutritive ingredients of food can be classified as follows: Of the actually nutritive substances or nutrients of foods the most important groups (exclusive of water) are—

1. ***Protein*** (proteids, albuminoids, &c.): *e. g.*, albumen ("white") of egg, fibrin of blood, "lean" of meat, gluten of wheat.

2. ***Fats:*** *e. g.*, fat of meat, butter, olive-oil.

3. ***Carbo-hydrates:*** *e. g.*, starch, sugar, glycogen.

4. ***Mineral matter or ash:*** *e. g.*, calcium and potassium phosphates and chlorides.

The terms protein, proteids, and albuminoids are applied somewhat indiscriminately, in ordinary usage, to several or all of certain classes of compounds characterized by containing nitrogen. The most important are the proteids or albuminoids, of which albumen, the white of egg, and myosin, the basis of muscle, are types. Allied to these, but occurring in smaller proportions in animal tissues and foods, are the nitrogenous compounds that make the basis of connective and other tissues. Gelatin is derived from some of these tissues, and may be taken as a type of the compounds of this class. As these constituents are of similar constitution, and have similar or nearly similar uses in nutrition, it is customary to group them together as protein. The muscular tissues of animals, and hence the lean portions of meat, fish, &c., contain small quantities of so-called nitrogenous extractives—creatin, carnin, &c. (contained in extract of meat, &c.)—which contribute materially to the flavor and somewhat to the nutritive effect of the foods containing them. They are not usually deemed of sufficient importance, however, to be grouped as a distinct class in tabular statements of the composition of foods. Concerning their chemical composition, it will suffice to state that the compounds classed together as protein contain carbon, oxygen, hydrogen, and nitrogen, while the carbo-hydrates and fats contain no nitrogen, but consist chiefly of carbon, oxygen, and hydrogen. The fats are much richer in carbon than the carbo-hydrates. Animal foods, as meats, fish, &c., contain but little of carbo-hydrates, their chief nutrients being protein and fats. Milk, however, and some shell-fish, as oysters, scallops, &c., contain more or less of carbo-hy-

drates. Vegetable foods, as wheat, potatoes, &c., contain less protein, and consist largely of starch, sugar, cellulose, and other carbo-hydrates.

Functions of nutrients.—The different nutrients have different offices in nourishing the body, in building up its tissues, repairing its wastes, and serving as fuel to produce animal heat and muscular and intellectual energy. The chief part borne by each in nutrition is shown below:

The protein of food	forms the (nitrogenous) basis of blood, muscle, connective tissue, &c. is transformed into fats and carbo-hydrates, and stored as such in the body. is consumed for fuel.
The fats of food	are stored as fat. are consumed for fuel.
The carbo-hydrates of food	are transformed into fat. are consumed for fuel.

In classifications formerly maintained and frequently met with still, the protein compounds were regarded as the "flesh-formers" and the sources of muscular energy, while the carbo-hydrates and fat were looked upon a "fat-formers" and "heat-producers." A vast deal of painstaking research, however, has shown that these distinctions were not correctly drawn. The albuminoids are flesh-formers, it is true; indeed, flesh, *i. e.*, muscular and other nitrogenous tissue, according to the nearly unanimous testimony of the most trustworthy experimenters, is made from the nitrogenous constituents of the food exclusively. But the balance of testimony is decidedly against the production of muscular energy by nitrogenous compounds exclusively or mainly. Each of the three groups of nutrients probably shares, directly or indirectly, in this function. So, too, it appears that the combustion which produces animal heat is not confined to the carbo-hydrates and fats, but the protein compounds, or the products of their decomposition, are also used for this purpose. Again, the production of fat in the body was formerly ascribed to the fats and carbo-hydrates alone. The view was held at the same time, and is still maintained, by some physiologists, that the carbohydrates cannot be transformed into fats, and that a very large part of the fat of the body is formed from the disintegration of the albuminoids. The weight of evidence to-day is decidedly in favor of the assumption that all three of the great classes of nutrients in our foods—the albuminoids, the carbohydrates, and the fats—are transformed into fat, and that the fat thus formed is consumed, either before or after being stored as body-fat.

It appears, then, that protein is the most important constituent of our food, because, while it performs the functions of each of the other two chief nutrients in being transformed into fat and in being consumed for fuel, it has a most weighty office of its own in forming the basis of the blood and in building up the muscular and other nitrogenous tissues, an office which no other nutrient can perform at all. And, as we

shall see further, in examining the pecuniary cost, protein is the dearest as well as most important of the ingredients of foods.

Experiments and observation have led to the assumption that the minimum proportions of the several classes of nutrients required per day by an ordinary man, doing moderate manual labor, would be, on the average: Protein, 118 grams (4.2 ounces); fats, 56 grams (2 ounces); carbohydrates, 500 grams (17.6 ounces).

Of course, the food actually consumed by people in different conditions of life varies widely in composition as well as amount. The food of people in good circumstances generally contains larger, and the food of the poor, smaller, proportions of protein than the above standard requires.

The same experimental research which has revealed to us the ways in which our food supplies our bodily wants, has shown us how to estimate the relative nutritive values of different foods from their chemical composition. The estimates are only approximate, because the nutritive effects are influenced by various conditions, some of which research has not yet definitely explained, while others vary with the nature of the food or of the user, so that the value of a given food in a given case may vary from the standard set by the analysis. These sources of uncertainty are nevertheless so narrowed down by late investigation, and the errors confined within such limits, that by intelligent use of the facts at our disposal we may judge very closely from the chemical composition of a food what is its value as compared with others of the same class, at any rate, for our nourishment.

CHEMICAL ANALYSIS OF FOODS.

Tables XI and XII, beyond, give the composition of a number of the more important kinds of animal and vegetable foods. The details will perhaps be best explained by an example. A sample of beef, sirloin, of medium fatness, was found to consist of about one-fourth bone and three-fourths flesh, edible substance. The flesh was analyzed and found to contain, nearly: water, 60 per cent.; protein, 19 per cent.; fats, 20 per cent.; mineral matters, 1 per cent. Calculated upon the whole sample of meat, of which one-fourth, or 25 per cent., was bone and other refuse, and 75 per cent. flesh, the analysis would stand as in the schedule below, in which the composition of the flesh by itself and that of the meat, bone, and all, are both given:

	In flesh, edible portion.	In meat as bought, including refuse.
	Per cent.	*Per cent.*
Refuse bone, &c	None.	25
Water	60	45
Protein	19	14¼
Fat	20	15
Mineral matters	1	0¾
Total	100	100

This very imperfect analysis may be stated in the following form, as is done in the tables beyond:*

Constituents of sample of beef, sirloin.

Food-material.	In edible portion, *i. e.*, flesh freed from bone and other refuse.					In meat as purchased, including both edible portion and refuse.					
			Nutrients.				Edible portion.				
									Nutrients.		
	Water.	Nutrients.	Protein.	Fats.	Mineral matters.	Refuse: Bones, &c.	Water.	Nutrients.	Protein.	Fats.	Mineral matters.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct*
Beef, sirloin, medium fatness ...	60	40	19	20	1	25	45	30	14.3	15	0.7

Table XI gives the composition of a number of animal foods, mostly from late American analyses. It is only a short time since analyses of American meats, &c., have been undertaken in any considerable number, and those as yet accomplished are far from sufficient for a complete survey of the subject. Indeed, the work already done can be regarded only as a beginning. Still, the figures will give a tolerably fair idea of the composition of the articles named.

The analyses of this table, with the exception of a few from European sources and indicated by italics, are selected from the results of the investigation referred to above, as conducted under the auspices of the Smithsonian Institution and the United States Fish Commission. The specimens of meats were purchased from a dealer in Middletown, Conn., and said by him to be "fair average samples of the better kinds of meats." A side of beef, freshly brought in the winter from Chicago, and said to be a good specimen of first-class "Chicago beef," was cut into about twenty-five pieces in the ordinary way. From each a sample fairly representing the whole cut was taken and analyzed. Thus the composition of each piece and of the whole side was learned. The composition of one of the leanest portions, the round, a moderately fat piece, sirloin, a very fat portion, flank, and of the whole side, together with a tongue, liver, and heart from another animal, are given in the table. The samples of a side of mutton and of parts of the same side were obtained and analyzed in like manner, as were those of the other meats and fowl. The specimens of meats were purchased in Middletown, Conn. Those of cheese were from Washington Market, New York; the analyses in the table represent the averages of several samples. The butter was from a Vermont dairy. The analyses of fish, &c., are taken from Tables VII and X. Some of the specimens were from Middletown, Conn., markets, but the majority were supplied by Mr. E. G. Blackford, of

* The tables contain also columns for carbohydrates, etc., which occur in milk and in some shell fish, but are not found in ordinary meats in sufficient amount to warrant their insertion in such tables as these.

Fulton Market, New York. A considerable number of the materials in Tables XI and XII were supplied by Mr. F. B. Thurber, of New York.

Table XII gives analyses of vegetable food materials and beverages. The figures for wheat flour represent the results of forty-nine analyses of American flours, of which the majority were analyzed under the direction of Professor Brewer, and the rest collated by him from other sources for the "Report of the United States Census, 1880." The largest and the smallest percentages of each ingredient found in the analyses are given opposite "maximum" and "minimum." The specimens of bread, crackers, &c., were purchased and analyzed at Middletown, Conn., and have probably about the usual composition of such materials. With these explanations I think the tables will require no further comment.

COMPARATIVE COSTS OF ACTUAL NUTRIENTS IN FISH AND OTHER FOODS.

A subject that has received but little attention in this country, though it has become a vital one in Europe, and is becoming so with us, is the cost of the nutritive material of our foods. The relative cheapness or dearness of different foods must be judged by comparing, not the prices per pound, but the costs of the actual nutrients. In making such comparisons, the cost may be assumed to fall, not upon the inedible portions and the water, but solely upon the three classes of nutrients: protein, fats, and carbohydrates. The relative physiological value of the nutrients in different foods depends upon (1) their digestibility and (2) their functions and the proportions in which they can replace each other in nutrition. An accurate physiological valuation is, in the present state of our knowledge, at least, impracticable. The pecuniary costs of the nutrients are, however, more nearly capable of approximation.

Various methods have been proposed for computing the relative pecuniary costs of the nutrients of foods, none of which, however, are entirely beyond criticism. The following, based upon German* estimates of the relative costs of protein fats and carbohydrates, is perhaps as satisfactory as any.

From extended comparisons of the composition and market prices of the more important animal and vegetable food-materials, such as meats, fish, flour, &c., those which serve for nourishment and not as luxuries, and form the bulk of the food of the people, it has been estimated that a pound of protein costs, on the average, five times as much, and a pound of fats three times as much, as a pound of carbohydrates; that, in other words, these three classes of nutrients stand related to each other, in respect to cost, in the following proportions:

Assumed ratios of costs in staple foods:	Protein	5
	Fats	3
	Carbohydrates	1

* König, *Nahrungsmittel* I. These figures demand revision for our markets, but are accurate enough for the present purpose, that of illustrating the comparative costliness of the nutritive material of our foods.

Suppose a pound of beef of average fatness to cost 25 cents and to contain 25 per cent. of inedible matters, bone, &c., 45 per cent of water, and 30 per cent. of nutritive substance, upon which latter—the bone and water being assumed to be without nutritive value—the whole cost comes. The 30 per cent. or 0.30 pounds of nutritive substance thus costs 25 cents; or at the rate of 83⅓ cents per pound. If, now, we leave out of account the minute quantities of carbohydrates and the mineral matters, the whole cost will fall upon the protein and fats. Assuming these to cost in the ratio of 5:3 and the amounts in the meat to be, protein 14¼ per cent. and fats 15 per cent., an easy computation will show the protein to cost 107.7 cents, and the fats 64.6 cents per pound. Proof: 0.1425 pound of protein at 107.7 cents=15.3 cents; 0.15 pounds of fats, at 64.6 cents=9.7 cents; 15.3 cents + 9.7 cents=25 cents, the cost of the pound of meat which contained the given amounts of protein and fats. The above ratios, protein: fats: carbohydrates=5:3:1, represent at best only general averages, and may in given cases be more or less incorrect. A method free from these objections consists in simply computing the amounts of nutrients that may be bought for the same price in different food-materials. At the same time the method above detailed is doubtless accurate enough for a general comparison of the relative cheapness and dearness of ordinary foods, and is used for the calculations in the table below.

Of the different nutrients, protein is physiologically the most important, as it is pecuniarily the most expensive. In fish, furthermore, as in the leaner kinds of meat, it is the predominant nutritive ingredient. For these reasons the cost of protein in fish and other foods may be used as a means of comparing their relative cheapness or dearness, as is done in the following table. The figures represent the ordinary prices per pound and the corresponding costs of protein, in specimens of food-materials obtained in New York and Middletown (Conn.) markets, and of which analyses are given. Though the number of specimens is too small for reliable averages, the figures, taken together, doubtless give a tolerably fair idea of the relative costliness of the nutrients in the different classes of foods.

Comparative costs of protein in animal and vegetable foods.

Foods.	Ordinary prices per pound.	Cost of protein per pound.
Meats, dairy products, &c.		
Beef:	*Cents.*	*Cents.*
Sirloin, medium fatness	25	108
Same, at lower price	20	86
Round, rather lean	18	70
Round, rather lean, lower price	16	62
Corned, lean	18	56
Flank,* very fat	15	36
Mutton:		
Leg	22	107
Side, medium fatness	20	59
Pork,* very fat	16	30
Smoked ham	18	48
Milk, 8 cents per quart	4	61

* Containing very little protein.

Comparative costs of protein in animal and vegetable foods—Continued.

Foods.	Ordinary prices per pound.	Cost of protein per pound.
Meats, dairy products, &c.—Continued.		
Cheese:	*Cents.*	*Cents.*
Whole milk	18	38
Skimmed milk	8	19
Fish, oysters, &c.		
Salmon:		
Early in season	100	572
When plenty	30	172
Shad	12	98
When abundant	8	65
Bluefish	10	98
Haddock	7	94
Halibut	15	87
Mackerel	10	80
When abundant	5	40
Cod	8	67
When plenty	6	50
Alewife	3	19
Canned salmon	20	70
Salt mackerel	12.5	46
Salt cod	7	38
Lower	6	33
Oysters:*		
25 cents per quart	12½	156
35 cents per quart	17.5	220
50 cents per quart, choice	25	312
Lobsters	12	209
Vegetable foods.		
Wheat-flour, best	5	19
Indian-corn (maize) meal	3	12
Oatmeal	5	15
Beans	5	14
Potatoes:†		
50 cents per bushel	0.8	14
100 cents per bushel	1.7	28

* Shell contents. † Containing very little protein.

Thus the nutrients of vegetable foods are, in general, much less costly than in animal foods. The animal foods have, however, the advantage of containing a larger proportion of protein and fats, and the protein, at least, in more digestible forms. And further, the so-called "nitrogenous extractives" (creatin, carnin, &c.,) of meats, which contribute so much to their agreeable flavor, exert a nutritive effect which, though not yet explained, is nevertheless important. It is these which give to "extract of meat" its peculiar flavor and stimulating effect.

Among the animal foods those which rank as delicacies are the costliest. By the above calculations the protein in the oysters costs from $2 to $3, and in salmon rises to nearly $6 per pound. In beef, mutton, and pork it varies from 108 to 48 cents; in shad, bluefish, haddock, and halibut the range is about the same, while in cod and mackerel, fresh and salted, it ranges from 67 to as low as 33 cents per pound. Salt cod and salt mackerel are nearly always, fresh cod and mackerel often, and even the choicer fish, as bluefish and shad, when abundant, cheaper sources of protein than any but the inferior kinds of meat.

In short we pay for many of our foods according to their agreeableness to our palates rather than their value for nourishing our bodies. At the same time it is interesting to note that the prices of the materials that make up the bulk of the food of the people seem to run more

or less parallel with their actual nutritive values. Here, as elsewhere, the resultant of the general experience of mankind has led slowly and blindly, but none the less surely, to the same general result to which accurate research more understandingly and quickly guides us.

The above calculations are open to the objection that the relative costs of protein, carbo-hydrates, and fats are only estimated and cannot be pronounced exactly accurate in any given case. In the following table the relative expensiveness of the foods is estimated in another way. From the price of a pound it is a very simple matter to calculate how much, in pounds and hundredths of a pound, any given sum, as 25 cents, would pay for. A comparison of this amount of the material with the percentages of the several nutrients the analysis shows it to contain gives the amounts of the several nutrients which would be supplied in 25 cents' worth of the food material. Here, as before, the figures are based upon the analyses.

COMPARATIVE EXPENSIVENESS OF FOODS.

Amounts of actual nutrients obtained for 25 cents in different food materials.

Food materials.	At prices per pound.	Quantities obtained for 25 cents, pounds and hundredths of a pound.			
		Food materials.	Actual nutrients in food materials.		
			Protein.	Fats.	Carbo-hydrates.
Beef:					
Sirloin, medium fatness	$0 25	1.00	.14	.15	
Sirloin, at lower price	20	1.25	.17	.19	
Round	18	1.38	.29	.11	
Mutton:					
Leg	22	1.13	.14	.31	
Side	20	1.25	.16	.29	
Pork (salted), fat	16	1.56	.04	1.19	
Milk, at 8 cents per quart	04	6.25	.21	.23	.30
Cheese:					
Whole milk	18	1.38	.37	.50	.03
Skim milk	08	3.12	1.19	.21	.28
Salmon:					
Early season	1 00	.25	.04	.02	
When plenty	30	.83	.12	.07	
Shad	12	2.84	.27	.15	
When abundant	08	3.12	.29	.15	
Bluefish	10	2.50	.25	.02	
Mackerel	10	2.50	.26	.11	
When plenty	05	5.00	.52	.22	
Cod	08	3.12	.36	.01	
When plenty	06	4.16	.48	.01	
Salt mackerel	12.5	2.00	.33	.35	
Salt cod	07	3.57	.66	.01	
Oysters:					
At 25 cents per quart	12.5	2.00	.12	.03	.08
At 35 cents per quart	17.5	1.42	.09	.02	.06
At 50 cents per quart	25	1.00	.06	.015	.04
Wheat flour (best)	05	5.00	.56	.06	3.78
Indian meal	03	8.33	.72	.29	6.03
Oatmeal	05	5.00	.76	.36	3.41
Beans	05	5.00	1.16	.11	2.87
Potatoes:					
At 50 cents per bushel	00.8	31.25	.63	.006	6.66
At $1 per bushel	01.7	15.62	.31	.003	3.00
Daily ration for ordinary man at moderate work			.26	.13	1.10

IN CONCLUSION—FISH AS FOOD.

Such facts as the following are among the more important ones to be gathered from the tabular statements herewith.

The flesh of fish contains, in general, about the same proportions of protein, less fat, more water, and hence, on the whole, less nutritive material than that of domestic animals used for food. Thus we have in the flesh of flounder only 16 per cent. and in that of cod 18 per cent. of nutrients, while ordinary lean beef has from 25 to 33 per cent., and the fatter meats considerably more. The fatter kinds of fish, however, as herring, mackerel, salmon, shad, and white fish, approach nearer to medium beef. Dried and salted fish also contain good proportions of nutrients, the specimens of ordinary salt codfish having 28 per cent., salt mackerel 47, and desiccated cod, a material as yet less known commercially, 82 per cent. of nutrients. The edible portion of shell-fish is poor in nutrients, oysters varying from 9 to 19 and lobsters averaging 18 per cent.

Fish as found in the markets generally contain more refuse, bone, skin, &c., than meats, as is illustrated in Tables V and X. With the larger proportions of both refuse and water the proportions of nutrients, though variable, are usually much less than in meats. Thus a sample of flounder contained 67 per cent. of refuse, 28 of water, and only 5 per cent. of nutritive substance, while the salmon averaged 23, the salt cod 22, and the salt mackerel 36 per cent. of nutrients. The nutrients in meats ranged from 30 per cent. in beef to 46 in mutton and 87½ in very fat pork (bacon). The canned fish compare very favorably with the meats. It is worth noting that the nutrients in fresh codfish, dressed, in oysters, edible portion, and in milk were nearly the same in amount, about 12½ per cent., though differing in kind and proportions.

Vegetable foods have generally less water and more nutrients than animal foods. Ordinary flour, meal, &c., contain from 85 to 90 per cent. or more of nutritive material. But the nutritive value is not proportional to the quantity of nutrients, because the vegetable foods consist mostly of carbo-hydrates, starch, sugar, cellulose, &c., of inferior nutritive effect, and because their protein is less digestible than that of animal foods. Potatoes especially contain a large amount of water and extremely little protein or fats.

PLACE OF FISH IN DIETARIES.—IMPORTANCE OF FISH CULTURE.

The chief uses of fish as food are (1) as an economical source of nutriment, and (2) to supply the demand for variety in diet, which increases with the advance of civilization and culture.

As nutriment, the place of fish is that of a supplement to vegetable foods, the most of which, as wheat, rye, maize, rice, potatoes, &c., are deficient in protein, the chief nutrient of fish.

The so-called nitrogenous extractives contained in small quantities in fish as in other animal foods are doubtless useful in nutrition. The

theory that fish is especially valuable for brain-food, on account of an assumed richness in phosphorus, is not sustained by the facts of either chemistry or physiology.

It is an interesting fact that the poorer classes of people and communities almost universally select those foods which chemical analysis shows to supply the actual nutrients at the lowest cost. But, unfortunately, the proportions of the nutrients in their dietaries are often very defective. Thus, in portions of India and China, rice; in Northern Italy, maize-meal; in certain districts of Germany and in some regions and seasons in Ireland, potatoes; and among the poor whites of the Southern United States, maize-meal and bacon make a large part and in some cases almost the sole food of the people. These foods supply the nutrients in the cheapest forms, but are all deficient in protein. The people who live upon them are ill-nourished and suffer physically, intellectually, and morally thereby.

On the other hand, the Scotchman finds a most economical supply of protein in oatmeal, haddock, and herring; and the rural inhabitants of New England supplement the fat of their pork with protein of beans, and the carbo-hydrates of potatoes, maize, and wheat flour with the protein of codfish and mackerel, and, while subsisting largely upon such frugal but rational diets, are well nourished, physically strong, and noted for their intellectual and moral force.

As population becomes denser, the capacity of the soil to supply food for man gradually nears its limit. Fish gather materials that would otherwise be inaccessible and lost, and store them in the very forms that are most deficient in the produce of the soil. Thus, by proper culture and use of fish, the rivers and the sea are made to fulfill their office with the land in supplying nutriment for man.

APPENDIX.

The following is a list of the larger tables in this article. Nos. I to VI, XI, and XII are, for convenience, placed in the appendix herewith; the rest are embodied in the text of the article.

Table I.—Analyses of fish (protein estimated by multiplying nitrogen by 6.25). In this table the specimens of fish are arranged in the order in which the analyses were made. Each bears the laboratory number by which it is referred to in the other tables and in the text. The "protein" is estimated by multiplying the nitrogen by 6.25. The figures for both "water-free substance" and "fresh substance" or flesh are given. For reasons given in the text, under "Methods of analysis" and "Nitrogen-factor of protein," I do not regard this as the most correct way of computing the analyses of materials which, like the flesh of fish, contain little of non-nitrogenous compounds other than fats and mineral matters, and have made no further use of the results thus obtained. In deference, however, to the very common usage of estimating "albuminoids" or "protein" by multiplying the nitrogen by 6.25 and stating results of analyses on this basis, I have given the results of all the analyses of the flesh of fish in this way in Table I.

Table II.—Analyses of fish (calculated on water-free substance, protein by difference). In this table the protein is estimated by subtracting the sum of ether extract and ash from 100.

The water-free substance consists essentially of nitrogenous compounds, insoluble or nearly insoluble in dry ether; fats, soluble in ether; and mineral matters, for the most part insoluble in ether and included in the ash. The determinations of ether extract were made in the nearly dried substance by use of purified and dried ether, and represent very nearly the actual quantities of fats. The figures for ash, though representing "crude ash," are a very nearly accurate measure of the actual amounts of mineral matters. I believe it correct to assume that the flesh of fish contains ordinarily but very little of non-nitrogenous compounds, other than fats and mineral compounds, though a more thorough study of the carbohydrates and complex nitrogenous and phosphorized fats is much needed. Accordingly it seems to me that in these analyses the most accurate measure of the nitrogenous compounds is to be found by subtracting the sum of the ether extract and ash from the whole. I have, therefore, in Table II, estimated the percentages of protein by subtracting the sum of ether extract and ash from 100.

The protein in Table II, therefore, includes all the nitrogenous compounds of the fish, albuminoids, gelatinoids, and so-called nitrogenous extractives.

In the preliminary report of progress of the present investigation, published in the Report of the United States Commission of Fish and Fisheries for 1880, pages 243–4, 273, and 275, are given results of determination of "extractives" (cold-water extract not coagulated on boiling), albumen (cold-water extract coagulated on boiling), gelatin (hot-water extract), and myosin and syntonin (insoluble protein) in a number of specimens of fish. I hope in a future report to discuss these compounds more fully, and hence only refer here to the analyses already reported. In Table II, as in the succeeding tables of the composition of fish, the terms protein and albuminoids, as said above, include all these nitrogenous compounds of the flesh. For the sake of completeness I give, with the protein thus calculated, the actual percentages of nitrogen.

Table III. Analyses of fish (calculated on fresh substance, protein by difference).—This table shows the composition of the flesh, as deduced from the figures for water and composition of water-free substance in Table II. Accordingly the protein is that estimated by difference.

Table IV. Analyses of fish (percentages of water and nutritive ingredients).—This table recapitulates in more convenient form the figures of Table III.

The insertion of both these tables may seem unnecessary. Table IV was already in type when a change of plan, necessitated by circumstances out of the writer's control, called for the details of Table III, and Table IV was allowed to stand. I think, however, it will not be entirely out of place. The figures for "maximum" and "minimum" represent the largest percentages of each of the several ingredients found in the specimens analyzed.

Table VI. Percentages of refuse, water, and nutritive ingredients in specimens of fish as found in the markets.—This table gives the composition of the specimens received for analysis, including both flesh and refuse, and is on that account of economic importance, since it shows the composition of the fish as commonly sold. The table is taken from a more detailed one, which with others I have reserved for a future and more extended report.

Table VII. Composition of invertebrates, &c.—This table, deduced from some more detailed tabular statements prepared for future publication, recapitulates some of the more important results, from the economic standpoint, of analyses of invertebrates (and two specimens of vertebrate animals). In many of the shell-fish—oysters, clams, mussels—the solid and liquid contents of the shells were analyzed separately. The amount of nitrogen and ether extract in the liquid portion seemed to me interesting, and led to more analyses of the latter than would otherwise have been undertaken. In removing the shell contents from

the shells for analysis, less was allowed to escape than is generally the case in the commercial process, I think, so that the specimens opened at the laboratory had doubtless a larger proportion of liquids than occur in those ordinarily found in the markets. This seems to be the explanation of the fact that the shell contents of the oysters received in the shell at the laboratory had larger proportions of ash than were found in the so-called "solids," as purchased of the oyster dealers.

The last two columns of Table VII need a word of explanation. They give the amounts of "edible portion" and "actual nutrients" in the whole specimens. In the case of oysters, for instance, the majority of the specimens were received in the shell. The percentages of edible portion—shell contents, flesh and liquids together—was of course small; that of water-free substance, which constitutes the nutritive material of the shell contents, was of course much smaller. If the mineral matter of the salt water were subtracted, as was not done, the amount of actual nutrients would be smaller still. If, however, the specimen consisted of the shell contents simply, of course the percentage of edible portion would be 100, and that of nutrients correspondingly large. In the lobsters, crabs, turtle, &c., the edible portion and nutrients are determined and stated in the same way as in the mollusks.

Tables VII to X are, I think, sufficiently explained in the text with which they are incorporated. They are derived from Tables II–VI.

Table XI is also explained in the text. The figures for meats, dairy products, &c, are, with the exception of some from European sources, and indicated by italics, compiled from the results of the analyses referred to in the beginning of this article as undertaken in behalf of the Smithsonian Institution (National Museum), but as yet unpublished. Those of fish, invertebrates, &c., are selected from the tables which I have just described. The minor differences between some of the figures for invertebrates, especially in this and the preceding tables, are due to the fact that, since this table was put in type, the former tables have been revised and slight changes introduced. Thus, in the revision, for "oysters best" a different specimen was selected from that whose composition had been given in Table XI. Of course, such matters as this are of small moment, and demand only a passing notice provided the analyses are in themselves correct.

Table XII. Analyses of vegetable food.—The reasons for inserting this table here are, that it is interesting for comparison with the fish and other animal foods and that some of its figures are used for data in computing the costs of nutrients in the section on the economic application of the analyses.

TABLE I.—*Analyses of fish (protein estimated by multiplying nitrogen by 6.25).*

Kind of fish.	Laboratory number of specimen.	In flesh.		In water-free substance.					In flesh, water + water-free.					
									Per analysis.					
		Water.	Water-free substance.	Nitrogen.	Protein, nitrogen × 6.25.	Fats, ether extract.	Crude ash.	Protein + fats + ash.	Nitrogen.	Water.	Protein, nitrogen × 6.25.	Fats, ether extract.	Crude ash.	Water + protein + fats + ash.
FRESH FISH.		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Halibut[1] (*Hippoglossus americanus*)	1	79.15	20.85	13.46	84.06	10.59	5.53	100.18	2.80	79.15	17.53	2.21	1.15	100.04
Flounder (*Paralichthys dentatus*)	2	83.37	16.63	14.35	89.69	3.73	7.67	101.09	2.39	83.37	14.91	0.62	1.28	100.18
Cod (*Gadus morrhua*)	3	83.48	16.52	15.00	93.75	1.66	7.62	103.03	2.48	83.48	15.49	0.28	1.27	100.52
Eel, salt-water (*Anguilla rostrata*)	4	69.80	30.20	10.20	63.75	34.23	3.04	101.02	3.08	69.80	19.25	10.34	0.91	100.30
Shad (*Alosa sapidissima*)	6	69.65	30.35	9.83	61.44	35.67	4.26	101.37	2.98	69.65	18.64	10.80	1.30	100.39
Striped bass (*Roccus lineatus*)	7	79.02	20.98	14.25	89.05	7.47	5.51	102.03	2.99	79.02	18.69	1.56	1.16	100.43
Mackerel (*Scomber scombrus*)	8	78.67	21.33	13.72	85.75	10.31	4.67	100.73	2.92	78.67	18.29	2.20	1.00	100.16
Halibut[2] (*Hippoglossus americanus*)	9	70.13	29.87	9.93	62.06	35.41	3.83	101.30	2.97	70.13	18.54	10.57	1.14	100.38
Shad (*Alosa sapidissima*)	10	65.25	34.75	9.18	57.38	39.10	4.26	100.74	3.18	65.25	19.89	13.59	1.48	100.21
Cod (*Gadus morrhua*)	11	83.39	16.61	15.50	96.88	2.39	7.60	106.87	2.58	83.39	16.09	0.40	1.36	101.14
Bluefish (*Pomatomus saltatrix*)	12	78.46	21.54	14.42	90.13	5.79	5.91	101.83	3.11	78.46	19.41	1 25	1.27	100.39
Mackerel (*Scomber scombrus*)	13	74.26	25.74	10.89	68.06	27.26	4.83	100.15	2.80	74.26	17.51	7.02	1.24	100.03
Salmon (*Salmo salar*)	14	67.15	32.85	9.57	59.81	37.94	3.35	101.10	3.14	67.15	19.63	12.47	1.21	100.46
Porgy (*Stenotomus argyrops*)	15	79.68	20.32	13.74	85.88	7.18	6.88	99.94	2.78	79.68	17.44	1.46	1.40	99.98
Haddock (*Melanogrammus æglefinus*)	16	80.30	19.70	15.08	94.25	0.85	5.82	100.92	2.97	80.30	18.58	0.17	1.15	100.20
Salmon trout (*Cristiromer namaycush*)	17	68.78	31.22	9.04	56.50	40 14	4.33	100.97	2.82	68.78	17.62	12.55	1.35	100.30
Whitefish (*Coregonus clupeiformis*)	18	69.83	30.17	12.16	76.00	21.51	5.36	102.87	3.67	69.83	22.93	6.49	1.62	100.87
Striped bass (*Roccus lineatus*)	19	79.73	20.27	13.40	83.78	10.49	6.69	100.96	2.72	79.73	16.98	2.17	1.30	100.24
Haddock (*Melanogrammus æglefinus*)	21	82.03	17.97	14.77	92.31	0.78	8.72	101.81	2.65	82.03	16.58	0.14	1.57	100.32
Flounder (*Paralichthys dentatus*)	22	85.04	14.96	14.14	88.38	5.18	8.63	102.19	2.12	85.04	13.22	0.77	1.29	100.32
Smelt (*Osmerus mordax*)	23	80.16	19.84	13.32	83.25	9.76	10.08	103.09	2.64	80.16	16.52	1.94	2.00	100.62
Brook trout (*Salvelinus fontinalis*)	24	77.54	22.46	13.25	82.81	11.61	6.33	100.75	2.98	77.54	18.60	2.61	1.42	100.17
Red snapper (*Lutjanus blackfordii*)	26	77.34	22.66	13.96	87.25	8.58	5.86	101.69	3.16	77.34	19.75	1.94	1.33	100.36
Mackerel (*Scomber scombrus*)	30	74.14	25.86	11.25	70.31	27.04	5.02	102.37	2.91	74.14	18.18	6.99	1.30	100.61
Porgy (*Stenotomus argyrops*)	31	71.98	28.02	10.77	67.31	28.04	4.81	100.16	3.02	71.98	18.86	7.86	1.35	100.05
Shad (*Alosa sapidissima*)	32	70.75	29.25	9.90	61.88	34.50	4.58	100.96	2.89	70.75	18.08	10.08	1.34	100.25
Blackfish (*Tautoga onitis*)	38	76.95	23.05	13.42	83.88	12.20	5.54	101.62	3.09	76.95	19.33	2.81	1.28	100.37
Mackerel (*Scomber scombrus*)	39	64.01	35.99	8.48	53.00	45.28	4.11	102.39	3.05	64.01	19.08	16.30	1.48	100.87
Spanish mackerel (*Cybium maculatum*)	43	68.10	31.90	10.76	67.25	29.56	4.71	101.52	3.43	68.10	21.45	9.43	1.50	100.48
White perch (*Morone americana*)	44	75.64	24.36	11.79	73.69	23.07	4.56	101.32	2.87	75.64	17.95	5.62	1.11	100.32

Mascalonge (*Esox nobilior*)	45	76.26	23.74	13.58	84.87	10.70	6.63	102.20	3.22	76.26	20.15	2.54	1.57	100.52
White perch (*Morone americana*)	46	75.77	24.23	13.59	84.94	10.42	5.27	100.63	3.29	75.77	20.58	2.52	1.28	100.15
Herring (*Clupea harengus*)	47	69.03	30.97	9.87	61.69	35.55	4.83	102.07	3.06	69.03	19.12	11.01	1.50	100.66
Sheepshead (*Archosargus probatocephalus*)	48	72.01	27.99	11.90	74.38	24.02	3.93	102.33	3.33	72.01	20.82	6.72	1.10	100.65
Yellow pike perch (*Stizostedium vitreum*)	52	79.74	20.26	14.67	91.69	2.31	6.75	100.75	2.97	79.74	18.58	0.47	1.37	100.16
Black bass (*Micropterus pallidus*)	53	78.61	21.39	14.54	90.88	4.47	5.57	100.92	3.11	78.61	19.44	0.96	1.19	100.20
Pollock (*Pollachius carbonarius*)	81	76.02	23.98	14.41	90.06	3.23	6.45	99.74	3.46	76.02	21.60	0.78	1.55	99.95
Butter-fish (*Poronotus triacanthus*)	90	70.02	29.98	9.60	60.00	36.80	3.82	100.62	2.88	70.02	17.99	11.03	1.14	100.18
Black bass (*Micropterus pallidus*)	91	74.82	25.18	13.79	86.19	9.69	4.93	100.81	3.47	74.82	21.71	2.44	1.24	100.21
Pickerel (*Esox lucius*)	98	79.79	20.21	14.78	92.38	2.87	5.07	100.32	2.99	79.79	18.67	0.58	1.03	100.07
Tomcod (*Microgadus tomcodus*)	99	81.55	18.45	14.95	93.44	2.08	5.32	100.84	2.76	81.55	17.24	0.38	0.99	100.16
Pickerel (*Esox reticulatus*)	100	79.84	20.16	14.63	91.43	2.58	6.14	100.15	2.96	79.84	18.43	0.52	1.24	100.03
Cusk (*Brosmius brosme*)	110	82.01	17.99	15.10	94.38	0.94	4.98	100.30	2.72	82.01	17.00	0.17	0.90	100.08
Cisco (*Argyrosomus tullibee*)	111	76.15	23.85	12.92	80.75	14.59	5.25	100.59	3.08	76.15	19.26	3.48	1.25	100.14
Hake (*Phycis chuss*)	113	83.11	16.89	14.56	91.00	3.97	5.77	100.74	2.46	83.11	15.37	0.67	0.98	100.13
Grouper (*Epinephelus morio*)	114	79.95	20.05	14.88	93.00	2.39	5.79	101.18	2.98	79.85	18.68	0.48	1.16	100.17
Mullet (*Mugil albula*)	126	74.87	25.13	12.40	77.50	18.45	4.66	100.61	3.12	74.87	19.48	4.64	1.17	100.16
Yellow perch (*Perca fluviatilis*)	127	80.43	19.57	14.54	90.88	2.81	5.86	99.55	2.85	80.43	17.79	0.55	1.14	99.91
Blackfish (*Tautoga onitis*)	205	81.36	18.64	15.12	94.52	2.95	3.48	100.95	2.82	81.36	17.61	0.55	0.65	100.17
Rock cod (*Gadus morrhua*)	206	80.71	19.29	15.20	95.00	1.54	7.22	103.76	2.93	80.71	18.32	0.30	1.40	100.73
Smelt (*Osmerus mordax*)	207	78.16	21.84	13.66	85.38	7.55	6.24	99.17	2.98	78.16	18.65	1.65	1.36	99.82
Yellow perch (*Perca fluviatilis*)	208	78.07	21.93	14.37	89.81	5.11	6.12	101.04	3.15	78.07	19.69	1.12	1.34	100.22
Halibut (*Hippoglossus americanus*)	211	76.97	23.03	13.67	85.43	11.95	3.81	101.19	3.15	76.97	19.68	2.75	0.88	100.28
Shad (*Alosa sapidissima*)	212	71.04	28.96	10.06	62.87	35.32	3.09	101.28	2.92	71.04	18.19	10.23	0.90	100.36
Eel, salt-water (*Anguilla rostrata*)	217	73.40	26.60	10.68	66.75	29.62	4.16	100.53	2.84	73.40	17.75	7.88	1.11	100.14
Alewife (*Pomolobus vernalis*)	220	72.96	27.04	11.67	72.94	22.28	5.48	100.70	3.16	72.96	19.72	6.02	1.48	100.18
Shad (*Alosa sapidissima*)	221	71.98	28.02	11.48	71.75	23.24	5.46	100.45	3.21	71.98	20.10	6.51	1.53	100.12
Pickerel (*Esox reticulatus*)	224	79.52	20.48	14.86	92.88	2.38	5.46	100.72	3.04	79.52	19.02	0.49	1.11	100.14
Striped bass (*Roccus lineatus*)	225	77.27	22.73	13.36	83.50	12.35	4.92	100.77	3.04	77.27	18.97	2.81	1.11	100.16
Cod (*Gadus morrhua*)	228	83.43	16.57	15.30	95.63	1.89	6.03	103.55	2.54	83.43	15.84	0.31	1.00	100.58
Haddock (*Melanogrammus æglefinus*)	229	82.56	17.44	14.97	93.56	1.82	6.78	102.16	2.61	82.56	16.32	0.32	1.18	100.38
Mackerel (*Scomber scombrus*)	230	73.68	26.32	11.85	74.06	22.28	4.60	100.94	3.12	73.68	19.46	5.86	1.21	100.21
California salmon[1] (*Oncorhynchus chouicha*)	233	64.53	35.47	8.37	52.31	46.51	2.85	101.67	2.97	64.53	18.56	16.50	1.01	100.60
Pompano (*Trachynotus carolinus*)	234	67.38	32.62	9.00	56.25	41.40	2.95	100.60	2.94	67.38	18.35	13.51	0.96	100.20
Lamprey eel (*Petromyzon marinus*)	236	71.12	28.88	8.30	51.88	46.03	2.27	100.18	2.40	71.12	14.98	13.29	0.66	100.05
Striped bass (*Roccus lineatus*)	237	75.76	24.24	12.90	80.63	15.02	5.23	100.88	3.13	75.76	19.54	3.64	1.27	100.21
Sturgeon[3] (*Acipenser sturio*)	238	78.71	21.29	13.63	85.19	8.90	6.72	100.81	2.90	78.71	18.11	1.90	1.43	100.15
Red snapper (*Lutjanus blackfordii*)	242	79.81	20.19	15.26	95.38	2.67	6.48	104.53	3.08	79.81	19.26	0.54	1.34	100.95
Cod (*Gadus morrhua*)	243	82.20	17.80	15.10	94.38	2.89	6.95	104.22	2.69	82.20	16.80	0.51	1.21	100.72
Blackfish (*Tautoga onitis*)	244	79.64	20.36	14.86	92.88	3.05	5.05	100.98	3.03	79.64	18.91	0.62	1.03	100.20
Shad (*Alosa sapidissima*)	245	72.14	27.86	10.57	66.06	29.10	5.52	100.68	2.95	72.14	18.40	8.08	1.54	100.16
Skate ([4]) (*Raia ——?*)	247	82.15	17.85	16.29	101.82	7.81	6.38	116.01	2.91	82.15	18.17	1.39	1.14	102.85
Striped bass (*Roccus lineatus*)	248	77.87	22.13	13.72	85.75	9.93	5.05	100.73	3.04	77.87	18.97	2.20	1.12	100.16
Shad (*Alosa sapidissima*)	249	73.56	26.44	11.06	69.13	26.58	5.16	100.87	2.92	73.56	18.27	7.03	1.36	100.22
Sheepshead (*Archosargus probatocephalus*)	250	79.08	20.92	14.81	92.56	3.16	6.36	102.08	3.10	79.08	19.36	0.66	1.33	100.43
Sea bass (*Centropristis atrarius*)	251	79.32	20.68	15.34	95.88	2.36	6.80	105.04	3.17	79.32	19.84	0.49	1.44	101.09
Kingfish (*Menticirrus nebulosus*)	252	79.21	20.79	14.57	91.08	4.53	5.68	101.29	3.03	79.21	18.94	0.95	1.18	100.28
Flounder (*Pseudopleuronectes americanus*)	253	84.35	15.65	14.86	92.88	2.85	7.68	103.41	2.33	84.35	14.53	0.44	1.20	100.52
Brook trout (*Salvelinus fontinalis*)	254	79.84	20.16	14.92	93.25	3.72	4.75	101.72	3.01	79.84	18.80	0.75	0.96	100.35
Salmon trout (*Cristivomer namaycush*)	255	69.50	30.50	10.19	63.69	33.47	3.85	101.01	3.11	69.50	19.42	10.21	1.17	100.30

[1] Posterior part of body lean. [2] Section of body fatter than 1. [3] Section of anterior part of body. [4] Left lobe of body.

TABLE I.—*Analyses of fish (protein estimated by multiplying nitrogen by 6.25)*—Continued.

Kind of fish.	Laboratory number of specimen.	In flesh.		In water-free substance.					In flesh, water + water-free.					
									Per analysis.					
		Water.	Water-free substance.	Nitrogen.	Protein, nitrogen × 6.25.	Fats, ether extract.	Crude ash.	Protein + fats + ash.	Nitrogen.	Water.	Protein, nitrogen × 6.25.	Fats, ether extract.	Crude ash.	Water + protein + fats + ash.
FRESH FISH—Continued.		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Canada brook trout (*Salvelinus fontinalis*)	256	75.78	24.22	13.41	83.81	12.14	5.08	101.03	3.25	75.78	20.30	2.94	1.25	100.27
Pike or gray perch (*Stizostedium canadensis*)	257	80.85	19.15	14.94	93.38	3.95	5.90	103.23	2.86	80.85	17.88	0.76	1.13	100.62
Buffalo-fish (*Myxostoma celata*)	258	78.56	21.44	13.43	83.94	10.98	5.56	100.48	2.88	78.56	17.99	2.35	1.19	100.09
Haddock (*Melanogrammus æglefinus*)	259	81.87	18.13	15.27	95.44	1.93	5.71	103.08	2.77	81.87	17.31	0.35	1.03	100.56
Striped bass (*Roccus lineatus*)	260	76.65	23.35	12.32	77.00	19.75	3.92	100.67	2.88	76.65	17.98	4.61	0.92	100.16
Mackerel (*Scomber scombrus*)	261	75.44	24.56	12.66	79.10	17.13	5.23	101.46	3.11	75.44	19.43	4.21	1.28	100.36
Porgy (*Stenotomus argyrops*)	262	73.31	26.69	11.65	72.81	22.54	5.22	100.57	3.11	73.31	19.42	6.01	1.39	100.14
Pompano (*Trachynotus carolinus*)	263	78.18	21.82	14.16	88.50	7.51	4.69	100.70	3.09	78.18	19.30	1.64	1.03	100.15
Blackfish (*Tautoga onitis*)	269	78.44	21.56	14.07	87.94	6.69	6.30	100.93	3.03	78.44	18.96	1.44	1.36	100.20
Red bass (*Sciænops ocellatus*)	270	81.56	18.44	14.65	91.56	2.89	6.67	101.12	2.70	81.56	16.88	0.53	1.23	100.20
Red grouper (*Epinephelus morio*)	271	78.96	21.04	15.06	94.13	3.39	5.42	102.94	3.17	78.96	19.81	0.71	1.14	100.62
Weakfish (*Cynoscion regalis*)	273	78.97	21.03	13.54	84.63	11.37	5.64	101.64	2.85	78.97	17.80	2.39	1.19	100.35
Salmon, female (*Salmo salar*)	279	61.37	38.63	10.24	64.00	33.76	3.51	101.27	3.95	61.37	24.72	13.04	1.36	100.49
Salmon, male (*Salmo salar*)	280	61.03	38.97	10.17	63.56	33.53	3.73	100.82	3.96	61.03	24.77	13.07	1.45	100.32
ROE.														
Shad roe	246	71.25	28.75	11.62	72.63	13.16	5.31	......	3.34	71.25	20.88	3.78	1.53	......
SPENT FISH.														
Salmon, male (*Salmo salar*)	35	75.27	24.73	12.39	77.44	17.66	4.51	99.61	3.06	75.27	19.15	4.37	1.12	99.91
Salmon, female (*Salmo salar*)	36	78.20	21.80	12.93	80.81	12.98	5.36	99.15	2.82	78.20	17.62	2.83	1.17	99.82
Land-locked salmon, male (*Salmo salar*, subsp. ***sebago***)	40	77.88	22.12	11.70	73.13	18.12	5.76	97.01	2.59	77.88	16.18	4.01	1.27	99.34
Land-locked salmon, female (*Salmo salar*, subsp. ***sebago***)	41	79.20	20.80	13.26	82.88	9.36	5.76	98.00	2.76	79.20	17.24	1.95	1.20	99.59
PRESERVED FISH.														
Boned cod (flesh freed from bone)	25	54.35	45.65	9.20	57.50	0.71	50.82	109.03	4.20	54.35	26.25	0.32	23.21	104.13
Smoked halibut (*Hippoglossus americanus*)	28	51.06	48.94	6.04	37.75	31.90	31.01	100.66	2.96	51.06	18.49	15.61	15.18	100.34
Canned salmon (*Oncorhynchus chouicha*)	29	65.86	34.14	9.87	61.69	32.40	5.24	99.33	3.37	65.86	21.06	11.06	1.79	99.77

... herring (*Clupea harengus*)	33	34.55	65.45	9.03	56.44	24.18	20.15	100.77	5.91	34.55	36.94	15.82	13.19	100.50
Salt cod (*Gadus morrhua*)	34	53.62	46.38	8.58	53.63	0.53	53.82	107.98	3.98	53.62	24.87	0.25	24.96	103.70
Salt cod (*Gadus morrhua*)	37	53.54	46.46	8.91	55.69	0.94	52.43	109.06	4.14	53.54	25.86	0.44	24.55	104.19
Salt mackerel, "No. 1 mackerel" (*Scomber scombrus*)	42	42.19	57.81	5.85	36.56	39.08	22.76	98.40	3.38	42.19	21.14	22.59	13.17	99.09
"Alden's dried fresh cod" (flesh desiccated)	79	15.25	84.75	14.72	92.00	2.24	9.78	104.02	12.48	15.25	77.97	1.90	8.29	103.41
Alden's dried salt cod (flesh desiccated)	80	11.65	88.35	13.04	81.50	5.54	13.40	100.44	11.52	11.65	72.02	4.89	11.84	100.40
Canned sardines (*Clupea pilchardus?*)	87	56.37	43.63	9.12	57.00	29.14	12.85	98.99	3.98	56.37	24.87	12.71	5.61	99.56
"Findon haddie," smoked haddock (*Melanogrammus æglefinus*)	88	72.56	27.44	13.58	84.88	0.62	13.10	98.60	3.73	72.56	23.29	0.17	3.59	99.61
Canned fresh mackerel (*Scomber scombrus*)	94	68.18	31.82	9.87	61.68	27.28	10.17	99.13	3.14	68.18	19.63	8.68	3.23	99.72
Canned salt mackerel (*Scomber scombrus*)	95	43.23	56.77	4.68	29.25	49.22	21.09	99.56	2.65	43.23	16.60	27.94	11.97	99.74
Canned salmon (*Oncorhynchus chouicha*)	96	62.23	37.77	8.48	53.00	38.55	9.34	100.89	3.20	62.23	20.02	14.55	3.53	100.33
Smoked halibut (*Hippoglossus americanus*)	218	47.70	52.30	7.04	44.00	27.61	28.42	100.03	3.68	47.70	23.01	14.44	14.86	100.01
Canned salt mackerel (*Scomber scombrus*)	219	43.62	56.38	5.08	31.75	44.05	24.53	100.33	2.86	43.62	17.90	24.84	13.83	100.19
Canned tunny (horse mackerel)	240	72.74	27.26	12.72	79.50	14.84	6.19	100.53	3.47	72.74	21.67	4.05	1.69	100.15
Canned salmon (*Oncorhynchus chouicha*)	241	57.55	42.45	7.34	45.88	50.62	4.15	100.65	3.12	57.55	19.47	21.49	1.76	100.27
Canned smoked haddock (*Melanogrammus æglefinus*)	275	68.73	31.27	11.40	71.25	7.18	23.14	101.57	3.56	68.73	22.28	2.25	7.24	100.50

Table II.—*Analyses of fish. Calculated on water-free substance. Percentages of protein (albuminoids) estimated by subtracting sum of fats and ash from 100.*

Kind of fish.	Laboratory number of specimen.	In flesh.		In water-free substance.			
		Water.	Water-free substance.	Nitrogen.	Protein by difference.	Fats: ether extract.	Crude ash.
FRESH FISH.		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Halibut[1] (*Hippoglossus americanus*)	1	79.15	20.85	13.45	83.88	10.59	5.53
Flounder (*Paralichthys dentatus*)	2	83.37	16.63	14.35	88.60	3.73	7.67
Cod (*Gadus morrhua*)	3	83.48	16.52	15.00	90.72	1.66	7.62
Eel, salt-water, (*Anguilla rostrata*)	4	69.80	30.20	10.20	62.73	34.23	3.04
Shad (*Alosa sapidissima*)	6	69.65	30.35	9.83	60.07	35.67	4.26
Striped bass (*Roccus lineatus*)	7	79.02	20.98	14.25	87.02	7.47	5.51
Mackerel (*Scomber scombrus*)	8	78.67	21.33	13.72	85.02	10.31	4.67
Halibut[2] (*Hippoglossus americanus*)	9	70.13	29.87	9.93	60.76	35.41	3.83
Shad (*Alosa sapidissima*)	10	65.25	34.75	9.18	56.64	39.10	4.26
Cod (*Gadus morrhua*)	11	83.39	16.61	15.50	90.01	2.39	7.60
Bluefish (*Pomatomus saltatrix*)	12	78.46	21.54	14.42	88.30	5.79	5.91
Mackerel (*Scomber scombrus*)	13	74.26	25.74	10.89	67.91	27.26	4.83
Salmon (*Salmo salar*)	14	67.15	32.85	9.57	58.71	37.94	3.35
Porgy (*Stenotomus argyrops*)	15	79.68	20.32	13.74	85.94	7.18	6.88
Haddock (*Melanogrammus æglefinus*)	16	80.30	19.70	15.08	93.33	0.85	5.82
Salmon trout (*Cristivomer namaycush*)	17	68.78	31.22	9.04	55.53	40.14	4.33
Whitefish (*Coregonus clupeiformis*)	18	69.83	30.17	12.16	73.13	21.51	5.36
Striped bass (*Roccus lineatus*)	19	79.73	20.27	13.40	82.82	10.49	6.69
Haddock (*Melanogrammus æglefinus*)	21	82.03	17.97	14.77	90.50	0.78	8.72
Flounder (*Paralichthys dentatus*)	22	85.04	14.96	14.14	86.19	5.18	8.63
Smelt (*Osmerus mordax*)	23	80.16	19.84	13.32	80.16	9.76	10.08
Brook trout (*Salvelinus fontinalis*)	24	77.54	22.46	13.25	82.06	11.61	6.33
Red snapper (*Lutjanus blackfordii*)	26	77.34	22.66	13.96	85.56	8.58	5.86
Mackerel (*Scomber scombrus*)	30	74.14	25.86	11.25	67.94	27.04	5.02
Porgy (*Stenotomus argyrops*)	31	71.98	28.02	10.77	67.15	28.04	4.81
Shad (*Alosa sapidissima*)	32	70.75	29.25	9.90	60.92	34.50	4.58
Blackfish (*Tautoga onitis*)	38	76.95	23.05	13.42	82.26	12.20	5.54
Mackerel (*Scomber scombrus*)	39	64.01	35.99	8.48	50.61	45.28	4.11
Spanish mackerel (*Cybium maculatum*)	43	68.10	31.90	10.76	65.73	29.56	4.71
White perch (*Morone americana*)	44	75.64	24.36	11.79	72.37	23.07	4.56
Mascalonge (*Esox nobilior*)	45	76.26	23.74	13.58	83.27	10.70	6.03
White perch (*Morone americana*)	46	75.77	24.23	13.59	84.31	10.42	5.27
Herring (*Clupea harengus*)	47	69.03	30.97	9.87	59.62	35.55	4.83
Sheepshead (*Archosargus probatocephalus*)	48	72.01	27.99	11.90	72.05	24.02	3.93
Yellow pike perch (*Perca fluviatilis*)	52	79.74	20.26	14.67	90.94	2.31	6.75
Black bass (*Micropterus pallidus*)	53	78.61	21.39	14.54	89.96	4.47	5.57
Pollock (*Pollachius carbonarius*)	81	76.02	23.98	14.41	90.32	3.23	6.45
Butter-fish (*Poronotus triacanthus*)	90	70.02	29.98	9.60	59.38	36.80	3.82
Black bass (*Micropterus pallidus*)	91	74.82	25.18	13.79	85.38	9.69	4.93
Pickerel (*Esox lucius*)	98	79.79	20.21	14.78	92.06	2.87	5.07
Tomcod (*Microgadus tomcodus*)	99	81.55	18.45	14.95	92.60	2.08	5.32
Pickerel (*Esox reticulatus*)	100	79.84	20.16	14.63	91.28	2.58	6.14
Cusk (*Brosmius brosme*)	110	82.01	17.99	15.10	94.08	0.94	4.98
Cisco (*Argyrosomus tullibee*)	111	76.15	23.85	12.92	80.16	14.59	5.25
Hake (*Phycis chuss*)	113	83.11	16.89	14.56	90.26	3.97	5.77
Grouper (*Epinephelus morio*)	114	79.85	20.15	14.88	91.82	2.39	5.79
Mullet (*Mugil albula*)	126	74.87	25.13	12.40	76.89	18.45	4.66
Yellow perch (*Perca fluviatilis*)	127	80.43	19.57	14.54	91.33	2.81	5.86
Blackfish (*Tautoga onitis*)	205	81.36	18.64	15.12	93.57	2.95	3.48
Rock cod (*Gadus morrhua*)	206	80.71	19.29	15.20	91.24	1.54	7.22
Smelt (*Osmerus mordax*)	207	78.16	21.84	13.66	86.21	7.55	6.24
Yellow perch (*Perca fluviatilis*)	208	78.07	21.93	14.37	88.77	5.11	6.12
Halibut (*Hippoglossus americanus*)	211	76.97	23.03	13.67	84.24	11.95	3.81
Shad (*Alosa sapidissima*)	212	71.04	28.96	10.06	61.59	35.32	3.09
Eel, salt-water, (*Anguilla rostrata*)	217	73.40	26.60	10.68	66.22	29.62	4.16
Alewife (*Pomolobus vernalis*)	220	72.96	27.04	11.67	72.24	22.28	5.48
Shad (*Alosa sapidissima*)	221	71.98	28.02	11.48	71.30	23.24	5.46
Pickerel (*Esox reticulatus*)	224	79.52	20.48	14.86	92.16	2.38	5.46
Striped bass (*Roccus lineatus*)	225	77.27	22.73	13.36	82.73	12.35	4.92
Cod (*Gadus morrhua*)	228	83.43	16.57	15.30	92.08	1.89	6.03
Haddock (*Melanogrammus æglefinus*)	229	82.56	17.44	14.97	91.40	1.82	6.78
Mackerel (*Scomber scombrus*)	230	73.68	26.32	11.85	73.12	22.28	4.60
California salmon (*Oncorhynchus chouicha*)	233	64.53	35.47	8.37	50.64	46.51	2.85
Pompano (*Trachynotus carolinus*)	234	67.38	32.62	9.00	55.65	41.40	2.95
Lamprey eel (*Petromyzon marinus.*)	236	71.12	28.88	8.30	51.70	46.03	2.27
Striped bass (*Roccus lineatus*)	237	75.76	24.24	12.90	79.75	15.02	5.23
Sturgeon[3] (*Acipenser sturio*)	238	78.71	21.29	13.63	84.38	8.90	6.72
Red snapper (*Lutjanus blackfordii*)	242	79.81	20.19	15.26	90.85	2.67	6.48
Cod (*Gadus morrhua*)	243	82.20	17.80	15.10	90.16	2.89	6.95

[1] Posterior part of body, lean. [2] Section of body fatter than 1. [3] Section of anterior part of body.

TABLE II.—*Analyses of fish. Calculated on water-free substance, &c.*—Continued.

Kind of fish.	Laboratory number of specimen.	In flesh.		In water-free substance.			
		Water.	Water-free substance.	Nitrogen.	Protein by difference.	Fats: ether extract.	Crude ash.
FRESH FISH—Continued.		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Blackfish (*Tautoga onitis*)	244	79.64	20.36	14.86	91.90	3.05	5.05
Shad (*Alosa sapidissima*)	245	72.14	27.86	10.57	65.38	29.10	5.52
Skate[1] (*Raia* ——?)	247	82.15	17.85	16.29	85.81	7.81	6.38
Striped bass (*Roccus lineatus*)	248	77.87	22.13	13.72	85.02	9.93	5.05
Shad (*Alosa sapidissima*)	249	73.56	26.44	11.06	68.26	26.58	5.16
Sheepshead (*Archosargus probatocephalus*)	250	79.08	20.92	14.81	90.48	3.16	6.36
Sea bass (*Centropristis atrarius*)	251	79.32	20.68	15.34	90.84	2.36	6.80
Kingfish (*Menticirrus nebulosus*)	252	79.21	20.79	14.57	89.79	4.53	5.68
Flounder (*Pseudopleuronectes americanus*)	253	84.35	15.65	14.86	89.47	2.85	7.68
Brook trout (*Salvelinus fontinalis*)	254	79.84	20.16	14.92	91.53	3.72	4.75
Salmon trout (*Cristivomer namaycush*)	255	69.50	30.50	10.19	62.68	33.47	3.85
Canada brook trout (*Salvelinus fontinalis*)	256	75.78	24.22	13.41	82.78	12.14	5.08
Pike or gray perch (*Stizostedium canadensis*)	257	80.85	19.15	14.94	90.15	3.95	5.90
Buffalo fish (*Myxostoma celata*)	258	78.56	21.44	13.43	83.46	10.98	5.56
Haddock (*Melanogrammus æglefinus*)	259	81.87	18.13	15.27	92.36	1.93	5.71
Striped bass (*Roccus lineatus*)	260	76.65	23.35	12.32	76.33	19.75	3.92
Mackerel (*Scomber scombrus*)	261	75.44	24.56	12.66	77.64	17.13	5.23
Porgy (*Stenotomus argyrops*)	262	73.31	26.69	11.65	72.24	22.54	5.22
Pompano (*Trachynotus carolinus*)	263	78.18	21.82	14.16	87.80	7.51	4.69
Blackfish (*Tautoga onitis*)	269	78.44	21.56	14.07	87.01	6.69	6.30
Red bass (*Sciænops ocellatus*)	270	81.56	18.44	14.65	90.44	2.89	6.67
Red grouper (*Epinephelus morio*)	271	78.96	21.04	15.06	91.19	3.39	5.42
Weakfish (*Cynoscion regalis*)	273	78.97	21.03	13.54	82.99	11.37	5.64
Salmon, female (*Salmo salar*)	279	61.37	38.63	10.24	62.73	33.76	3.51
Salmon, male (*Salmo salar*)	280	61.03	38.97	10.17	62.74	33.53	3.73
SPENT FISH.							
Salmon, male (*Salmo salar*)	35	75.27	24.73	12.39	77.83	17.66	4.51
Salmon, female (*Salmo salar*)	36	78.20	21.80	12.93	81.66	12.98	5.36
Land-locked salmon, male (*Salmo salar*, subsp. *sebago*)	40	77.88	22.12	11.70	76.12	18.12	5.76
Land-locked salmon, female (*Salmo salar*, subsp. *sebago*)	41	79.20	20.80	13.26	84.88	9.36	5.76
PRESERVED FISH.							
Boned salt cod (flesh freed from bone)	25	54.35	45.65	9.20	48.57	0.71	50.72
Smoked halibut (*Hippoglossus americanus*)	28	51.06	48.94	6.04	37.09	31.90	31.01
Canned salmon (*Oncorhynchus chouicha*)	29	65.86	34.14	9.87	62.36	32.40	5.24
Smoked herring (*Clupea harengus*)	33	34.55	65.45	9.03	55.67	24.18	20.15
Salt cod (*Gadus morrhua*)	34	53.62	46.38	8.58	45.65	0.53	53.82
Salt cod (*Gadus morrhua*)	37	53.54	46.46	8.91	46.63	0.94	52.43
Salt mackerel, "No. 1 mackerel" (*Scomber scombrus*)	42	42.19	57.81	5.85	38.16	39.08	22.76
Alden's dried fresh cod (flesh desiccated)	79	15.25	84.75	14.72	87.98	2.24	9.78
Alden's dried salt cod (flesh desiccated)	80	11.65	88.35	13.04	81.06	5.54	13.40
Canned sardines (*Clupea pilchardus?*)	87	56.37	43.63	9.12	58.01	29.14	12.85
"Findon haddie" (smoked haddock). (*Melanogrammus æglefinus*)	88	72.56	27.44	13.58	86.28	0.62	13.10
Canned fresh mackerel (*Scomber scombrus*)	94	68.18	31.82	9.87	62.55	27.28	10.17
Canned salt mackerel (*Scomber scombrus*)	95	43.23	56.77	4.68	29.69	49.22	21.09
Canned salmon (*Oncorhynchus chouicha*)	96	62.23	37.77	8.48	52.11	38.55	9.34
Smoked halibut (*Hippoglossus americanus*)	218	47.70	52.30	7.04	43.97	27.61	28.42
Canned salt mackerel (*Scomber scombrus*)	219	43.62	56.38	5.08	31.42	44.05	24.53
Canned tunny. "Horse mackerel"	240	72.74	27.26	12.72	78.97	14.84	6.19
Canned salmon (*Oncorhynchus chouicha*)	241	57.55	42.45	7.34	45.23	50.62	4.15
Canned smoked haddock (*Melanogrammus æglefinus*)	275	68.73	31.27	11.40	69.68	7.18	23.14

[1] Left lobe of body.

TABLE III.—*Analyses of fish. Composition of flesh. Protein (albuminoids) estimated by difference.*

Kind of fish.	Laboratory number of specimen.	Salt.*	Water.	Water-free substance.	In water-free substance. Protein by difference.	Fats.	Ash.	Nitrogen.
FRESH FISH.		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Alewife (*Pomolobus vernalis*)	220		72.96	27.04	19.54	6.02	1.48	3.16
Black bass (*Micropterus pallidus*)	53		78.61	21.39	19.24	0.96	1.19	3.11
Black bass (*Micropterus pallidus*)	91		74.82	25.18	21.50	2.44	1.24	3.47
Average of two specimens			76.71	23.29	20.37	1.70	1.22	3.29
Red bass (*Sciænops ocellatus*)	270		81.56	18.44	16.68	0.53	1.23	2.70
Sea bass (*Centropristis atrarius*)	251		79.32	20.68	18.75	0.49	1.44	3.17
Striped bass (*Roccus lineatus*)	7		79.02	20.98	18.26	1.56	1.16	2.99
Striped bass (*Roccus lineatus*)	19		79.73	20.27	16.74	2.17	1.36	2.72
Striped bass (*Roccus lineatus*)	225		77.27	22.73	18.81	2.81	1.11	3.04
Striped bass (*Roccus lineatus*)	237		75.76	24.24	19.33	3.64	1.27	3.13
Striped bass (*Roccus lineatus*)	248		77.87	22.13	18.81	2.20	1.12	3.04
Striped bass (*Roccus lineatus*)	260		76.65	23.35	17.82	4.61	0.92	2.88
Average of six specimens			77.71	22.29	18.30	2.83	1.16	2.93
Blackfish (*Tautoga onitis*)	38		76.95	23.05	18.96	2.81	1.28	3.09
Blackfish (*Tautoga onitis*)	205		81.36	18.64	17.44	0.55	0.65	2.82
Blackfish (*Tautoga onitis*)	244		79.64	20.36	18.71	0.62	1.03	3.03
Blackfish (*Tautoga onitis*)	269		78.44	21.56	18.76	1.44	1.36	3.03
Average of four specimens			79.10	20.90	18.47	1.35	1.08	2.99
Bluefish (*Pomatomus saltatrix*)	12		78.46	21.54	19.02	1.25	1.27	3.11
Buffalo-fish (*Myxostoma celata*)	258		78.56	21.44	17.90	2.35	1.19	2.88
Butter-fish (*Poronotus triacanthus*)	90		70.02	29.98	17.81	11.03	1.14	2.88
Cisco (*Argyrosomus tullibee*)	111		76.15	23.85	19.12	3.48	1.25	3.08
Cod (*Gadus morrhua*)	3		83.48	16.52	14.97	0.28	1.27	2.48
Cod (*Gadus morrhua*)	11		83.39	16.61	14.95	0.40	1.26	2.58
Cod (*Gadus morrhua*)	206		80.71	19.29	17.59	0.30	1.40	2.93
Cod (*Gadus morrhua*)	228		83.43	16.57	15.26	0.31	1.00	2.01
Cod (*Gadus morrhua*)	243		82.20	17.80	16.08	0.51	1.21	2.69
Average of five specimens			82.64	17.36	15.77	0.36	1.23	2.54
Cusk (*Brosmius brosme*) (*americanus*)	110		82.01	17.99	16.92	0.17	0.90	2.72
Eel, salt-water (*Anguilla rostrata*)	4		69.80	30.20	18.95	10.34	0.91	3.08
Eel, salt-water (*Anguilla rostrata*)	217		73.40	26.60	17.61	7.88	1.11	2.84
Average of two specimens			71.60	28.40	18.28	9.11	1.01	2.96
Lamprey eel (*Petromyzon marinus?*)	236		71.12	28.88	14.93	13.29	0.66	2.40
Flounder (*Paralichthys dentatus*)	2		83.37	16.63	14.73	0.62	1.28	2.39
Flounder (*Paralichthys dentatus*)	22		85.04	14.96	12.90	0.77	1.29	2.12
Average of two specimens			84.21	15.79	13.82	0.69	1.28	2.26
Flounder (*Pseudopleuronectes americanus*)	253		84.35	15.65	14.01	0.44	1.20	2.33
Grouper (*Epinephelus morio*)	114		79.85	20.15	18.51	0.48	1.16	2.98
Grouper (*Epinephelus morio*)	271		78.96	21.04	19.19	0.71	1.14	3.11
Average of two specimens			79.40	20.60	18.85	0.60	1.15	3.04
Haddock (*Melanogrammus æglefinus*)	16		80.30	19.70	18.38	0.17	1.15	2.97
Haddock (*Melanogrammus æglefinus*)	21		82.03	17.97	16.26	0.14	1.57	2.65
Haddock (*Melanogrammus æglefinus*)	229		82.56	17.44	15.94	0.32	1.18	2.61
Haddock (*Melanogrammus æglefinus*)	259		81.87	18.13	16.75	0.35	1.03	2.77
Average of four specimens			81.69	18.31	16.83	0.25	1.23	2.75
Hake (*Phycis chuss*)	113		83.11	16.89	15.24	0.67	0.98	2.46
Halibut (*Hippoglossus americanus*). Section of body	1		79.15	20.85	17.49	2.21	1.15	2.80
Halibut (*Hippoglossus americanus*). Section of body	9		70.13	29.87	18.16	10.57	1.14	2.97
Halibut (*Hippoglossus americanus*	211		76.97	23.03	19.40	2.75	0.88	3.15
Average of three specimens			75.42	24.58	18.35	5.17	1.06	2.97
Herring (*Clupea harengus*)	47		69.03	30.97	18.46	11.01	1.50	3.06
King fish (*Menticirrus nebulosus*)	252		79.21	20.79	18.66	0.95	1.18	3.03
Mascalonge (*Esox nobilior*)	45		76.26	23.74	19.63	2.54	1.57	3.22
Mackerel (*Scomber scombrus*)	8		78.67	21.33	18.13	2.20	1.00	2.92
Mackerel (*Scomber scombrus*)	13		74.26	25.74	17.48	7.02	1.24	2.80
Mackerel (*Scomber scombrus*)	30		74.14	25.86	17.42	6.94	1.50	2.91
Mackerel (*Scomber scombrus*)	39		64.01	35.99	18.21	16.30	1.48	3.05
Mackerel (*Scomber scombrus*)	230		73.68	26.32	19.25	5.86	1.21	3.12
Mackerel (*Scomber scombrus*)	261		75.44	24.56	19.07	4.21	1.28	3.11
Average of six specimens			73.37	26.63	18.26	7.09	1.28	2.99
Spanish mackerel (*Cybium maculatum*)	43		68.10	31.90	20.97	9.43	1.50	3.43
Mullet (*Mugil albula*)	126		74.87	25.13	19.32	4.64	1.17	3.12

* In computing the mineral matter in the salted fish, it was assumed that percentages of the mineral matters properly belonging to the fish would be the same as in corresponding specimens of fresh fish. These percentages are computed for the salt fish, and the excess of ash found in the salt fish is taken as "salt."

Table III.—*Analyses of fish. Composition of flesh, &c.*—Continued.

Kind of fish.	Laboratory number of specimen.	Salt.*	Water.	Water-free substance.	In water-free substance. Protein by difference.	Fats.	Ash.	Nitrogen.
Fresh fish—Continued.		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
ompano (*Trachynotus carolinus*)	234		67.38	32.62	18.15	13.51	0.96	2.94
ompano (*Trachynotus carolinus*)	263		78.18	21.82	19.15	1.64	1.03	3.09
Average of two specimens			72.78	27.22	18.65	7.57	1.00	3.02
ike perch (*Stizostedium canadensis*)	257		80.85	19.15	17.26	0.76	1.13	2.86
Vhite perch (*Morone americana*)	44		75.64	24.36	17.63	5.62	1.11	2.87
Vhite perch (*Morone americana*)	46		75.77	24.23	20.43	2.52	1.28	3.29
Average of two specimens			75.71	24.29	19.03	4.07	1.19	3.08
ellow perch (*Perca fluviatilis*)	127		80.43	19.57	17.88	0.55	1.14	2.85
ellow perch (*Perca fluviatilis*)	208		78.07	21.93	19.47	1.12	1.34	3.15
Average of two specimens			79.25	20.75	18.68	0.83	1.24	3.00
ike perch (*Stizostedium vitreum*)	52		79.74	20.26	18.42	0.47	1.37	2.97
ickerel (*Esox lucius*)	98		79.79	20.21	18.60	0.58	1.03	2.99
ickerel (*Esox reticulatus*)	100		79.84	20.16	18.40	0.52	1.24	2.96
ickerel (*Esox reticulatus*)	224		79.52	20.48	18.88	0.49	1.11	3.04
Average of two specimens			79.68	20.32	18.64	0.50	1.18	3.00
ollock (*Pollachius carbonarius*)	81		76.02	23.98	21.65	0.78	1.55	3.46
orgy (*Stenotomus argyrops*)	15		79.68	20.32	17.46	1.46	1.40	2.78
orgy (*Stenotomus argyrops*)	31		71.98	28.02	18.81	7.86	1.35	3.02
orgy (*Stenotomus argyrops*)	262		73.31	26.69	19.29	6.01	1.39	3.11
Average of three specimens			74.99	25.01	18.52	5.11	1.38	2.97
ed snapper (*Lutjanus blackfordii*)	26		77.34	22.66	19.39	1.94	1.33	3.16
ed snapper (*Lutjanus blackfordii*)	242		79.81	20.19	18.31	0.54	1.34	3.08
Average of two specimens			78.58	21.42	18.85	1.24	1.33	3.12
almon (*Salmo salar*)	14		67.15	32.85	19.17	12.47	1.21	3.14
almon (*Salmo salar*). Female	279		61.37	38.63	24.23	13.04	1.36	3.95
almon (*Salmo salar*). Male	280		61.03	38.97	24.45	13.07	1.45	3.96
Average of three specimens			63.18	36.82	22.62	12.86	1.34	3.86
alifornia salmon (*Oncorhynchus chouicha*)	233		64.53	35.47	17.96	16.50	1.01	2.97
had (*Alosa sapidissima*)	6		69.65	30.35	18.25	10.80	1.30	2.98
had (*Alosa sapidissima*)	10		65.25	34.75	19.68	13.59	1.48	3.18
had (*Alosa sapidissima*)	32		70.75	29.25	17.83	10.08	1.34	2.89
had (*Alosa sapidissima*)	212		71.04	28.96	17.83	10.23	0.90	2.92
had (*Alosa sapidissima*)	221		71.98	28.02	19.98	6.51	1.53	3.21
had (*Alosa sapidissima*)	245		72.14	27.86	18.24	8.08	1.54	2.95
had (*Alosa sapidissima*)	249		73.56	26.44	18.05	7.03	1.36	2.96
Average of seven specimens			70.62	29.38	18.56	9.47	1.35	3.01
kate (*Raia*——?). Left lobe of body	247		82.15	17.85	15.32	1.39	1.14	2.91
heepshead (*Archosargus probatocephalus*)	48		72.01	27.99	20.17	6.72	1.10	3.33
heepshead (*Archosargus probatocephalus*)	250		79.08	20.92	18.93	0.66	1.33	3.10
Average of two specimens			75.55	24.45	19.54	3.69	1.22	3.22
melt (*Osmerus mordax*)	23		80.16	19.84	15.90	1.94	2.00	2.64
melt (*Osmerus mordax*)	207		78.16	21.84	18.83	1.65	1.36	2.98
Average of two specimens			79.16	20.84	17.37	1.79	1.68	2.81
turgeon (*Acipenser sturio*). Section of body	238		78.71	21.29	17.96	1.90	1.43	2.90
omcod (*Microgadus tomcodus*)	99		81.55	18.45	17.08	0.38	0.99	2.76
almon trout "Mackinaw trout" (*Cristivomer namaycush*)	17		68.78	31.22	17.34	12.53	1.35	2.82
almon trout "Mackinaw trout" (*Cristivomer namaycus*)	255		69.50	30.50	19.12	10.21	1.17	3.11
Average of two specimens			69.14	30.86	18.34	11.26	1.26	2.97
rook trout (*Salvelinus fontinalis*)	24		77.54	22.46	18.43	2.61	1.42	2.98
rook trout (*Salvelinus fontinalis*)	254		79.84	20.16	18.45	0.75	0.96	3.01
rook trout (*Salvelinus fontinalis*)	256		75.78	24.22	20.03	2.94	1.25	3.25
Average of three specimens			77.72	22.28	18.97	2.10	1.21	3.08
hitefish (*Coregonus clupeiformis*)	18		69.83	30.17	22.06	6.49	1.62	3.67
eakfish (*Cynoscion regalis*)	273		78.97	21.03	17.45	2.39	1.19	2.85
SPENT FISH.								
lmon (*Salmo salar*). Male	35		75.27	24.73	19.24	4.37	1.12	3.06
lmon (*Salmo salar*). Female	36		78.20	21.80	17.80	2.83	1.17	2.82
Average of two specimens			76.74	23.26	18.52	3.60	1.14	2.94

*In computing the mineral matter in the salted fish, it was assumed that percentages of the mineral tters properly belonging to the fish would be the same as in corresponding specimens of fresh fish. ese percentages are computed for the salt fish, and the excess of ash found in the salt fish is taken "salt."

TABLE III.—*Analyses of fish. Composition of flesh, &c.*—Continued.

Kind of fish.	Laboratory number of specimen.	Salt.*	Water.	Water-free substance.	In water-free substance.			Nitrogen.
					Protein by difference.	Fats.	Ash.	
SPENT FISH—Continued.		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Salmon, land-locked (*Salmo salar*, subps. *sebago*). Male	40	....	77.88	22.12	16.84	4.01	1.27	2.5
Salmon, land-locked (*Salmo salar*, subsp. *sebago*). Female	41	....	79.20	20.80	17.65	1.95	1.20	2.7
Average of two specimens	......	....	78.54	21.46	17.24	2.98	1.24	2.6
PREPARED FISH.								
Dried.								
Desiccated cod. Flesh freed from bone and dried	**79**	**2.88**	**15.25**	**81.87**	**74.56**	**1.90**	5.41	**12.4**
Salted.								
Mackerel (*Scomber scombrus*). "No.1 mackerel"	42	**10.60**	**42.19**	**47.21**	22.05	22.59	2.57	**3.3**
Salted and dried.								
Cod (*Gadus morrhua*) "channel fish"	34	20.95	53.62	25.43	21.17	0.25	4.01	3.9
Cod (*Gadus morrhua*) "boat fish"	37	20.22	53.54	26.24	21.67	0.44	4.13	4.1
Average of two specimens	......	20.58	53.58	25.84	21.42	0.34	4.08	4.0
Boned cod. Flesh freed from bone	25	19.13	54.35	26.52	22.12	0.32	4.08	4.2
Desiccated cod. Flesh freed from bone and dried	80	6.60	11.65	81.75	71.62	4.89	5.24	11.5
Salted, smoked, and dried.								
Haddock "Findon haddie" (*Melanogrammus æglefinus*)	88	2.06	72.56	25.38	23.68	0.17	1.53	3.7
Halibut (*Hippoglossus americanus*)	28	13.05	51.06	35.89	18.15	15.61	2.13	2.9
Halibut (*Hippoglossus americanus*)	218	12.87	47.70	39.43	23.00	14.44	1.99	3.6
Average of two specimens	......	12.96	49.38	37.66	20.57	15.03	2.06	3.3
Herring (*Clupea harengus*)	33	11.66	34.55	53.79	36.44	15.82	1.53	5.9
Canned.								
Mackerel (*Scomber scombrus*)	94	1.93	68.18	29.89	19.91	8.68	1.30	3.
Salmon (*Oncorhynchus chouicha*)	29	0.53	65.86	33.61	21.29	11.06	1.26	3.
Salmon (*Oncorhynchus chouicha*)	96	2.19	62.23	35.58	19.69	14.55	1.34	3.
Salmon (*Oncorhynchus chouicha*)	241	0.41	57.55	42.04	19.20	21.49	1.35	3.
Average of two specimens	......	1.30	59.89	38.81	19.44	18.02	1.35	3.
Sardines (*Clupea pilchardus*)	87	....	56.37	46.63	25.31	12.71	5.61	3.
Tunny. "Horse mackerel." (*Orcynus secundo-dorsalis ?*)	240	....	72.74	27.26	21.52	4.05	1.69	3.
Mackerel (*Scomber scombrus*), "No. 2 mackerel," salted	95	9.44	43.23	47.33	16.86	27.94	2.53	2.
Mackerel (*Scomber scombrus*), "No. 2 mackerel," salted	219	11.16	43.62	45.22	17.71	24.84	2.67	2.
Average of two specimens	......	10.30	43.43	46.27	17.28	26.39	2.60	2.
Smoked haddock (*Melanogrammus æglefinus*)	275	5.59	68.73	25.68	21.78	2.25	1.65	3.

* In computing the mineral matter in the salted fish, it was assumed that the percentages of mine[ral] matters properly belonging to the fish would be the same as in corresponding specimens of fresh fi[sh]. These percentages are computed for the salt fish, and the excess of ash found in the salt fish is tak[en] as "salt."

TABLE IV.—*Percentages of water and nutritive ingredients in flesh, edible portion, of American food-fishes.*

Number of specimens analyzed.	Kinds of fish.	Salt.*	In flesh, edible portion.					
			Water.	Water-free substance (total nutrients).	Ingredients of water-free substance, nutrients.			Nitrogen.
					Albuminoids by difference.	Fats.	Mineral matters.	
	FRESH FISH.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1	Alewife (*Pomolobus vernalis*)	....	72.96	27.04	19.54	6.02	1.48	3.16
2	Black bass (*Micropterus pallidus*):							
	Maximum	....	78.61	25.18	21.50	2.44	1.24	3.47
	Minimum	....	74.82	21.39	19.24	0.96	1.19	3.11
	Average	....	76.71	23.29	20.37	1.70	1.22	3.29
1	Red bass (*Sciænops ocellatus*)	....	81.56	18.44	16.68	0.53	1.23	2.70
1	Sea bass (*Centropristis atrarius*)	....	79.32	20.68	18.75	0.49	1.45	3.17
6	Striped bass (*Roccus lineatus*):							
	Maximum	....	79.73	24.24	19.33	4.61	1.36	3.13
	Minimum	....	75.76	20.27	16.74	1.56	0.92	2.72
	Average	....	77.71	22.29	18.30	2.83	1.16	2.54
4	Black-fish (*Tautoga onitis*):							
	Maximum	....	81.36	23.05	18.96	2.81	1.36	3.09
	Minimum	....	76.95	18.64	17.44	0.55	0.65	2.82
	Average	....	79.10	20.90	18.47	1.35	1.08	2.99
1	Blue-fish (*Pomatomus saltatrix*)	....	78.46	21.54	19.02	1.25	1.27	3.11
1	Buffalo-fish (*Myxostoma celata*)	....	78.56	21.44	17.90	2.35	1.19	2.88
1	Butter-fish (*Poronotus triacanthus*)	....	70.02	29.98	17.81	11.03	1.14	2.88
1	Ciscoe (*Argyrosomus tullibee*)	....	76.15	23.85	19.12	3.48	1.25	3.08
5	Cod (*Gadus morrhua*):							
	Maximum	....	83.48	19.29	17.59	0.51	1.40	2.93
	Minimum	....	80.71	16.52	14.95	0.28	1.00	2.01
	Average	....	82.64	17.36	15.77	0.36	1.23	2.54
1	Cusk (*Brosmius brosme*)	....	82.01	17.99	16.92	0.17	0.90	2.72

* In computing the mineral matters in the salted fish it was assumed that the mineral matters properly belonging to the fish would bear the same relation to the flesh (albuminoid plus fats) as in the averages of the corresponding samples of fresh fish. The excess actually found is counted as salt.

TABLE IV.—*Percentages of water and nutritive ingredients, &c.*—Continued.

Number of specimens analyzed.	Kinds of fish.	Salt.	In flesh, edible portion.					
			Water.	Water-free substance (total nutrients).	Ingredients of water-free substance, nutrients.			Nitrogen.
					Albuminoids by difference.	Fats.	Mineral matters.	
	FRESH FISH—Continued.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2	Eel, salt water (*Anguilla rostrata*):							
	Maximum		73.40	30.20	18.95	10.34	1.11	3.08
	Minimum		69.80	26.60	17.61	7.88	0.91	2.84
	Average		71.60	28.40	18.28	9.11	1.01	2.96
1	Lamprey eel (*Petromyzon marinus*)		71.12	28.88	14.93	13.29	0.66	2.40
2	Flounder (*Paralichthys dentatus*), average		84.21	15.79	13.82	0.69	1.28	2.26
1	Flounder (*Pseudopleuronectes americanus*)		84.35	15.65	14.01	0.44	1.20	2.33
2	Grouper (*Epinephelus morio*), average		79.40	20.60	18.85	0.60	1.15	3.04
4	Haddock (*Melanogrammus æglefinus*), average		81.69	18.31	16.83	0.25	1.23	2.75
1	Hake (*Phycis chuss*)		83.11	16.89	15.24	0.67	0.98	2.46
3	Halibut (*Hippoglossus americanus*):							
	Maximum		79.15	29.87	19.40	10.57	1.15	3.15
	Minimum		70.13	20.85	17.49	2.21	0.88	2.80
	Average		75.42	24.58	18.35	5.17	1.06	2.97
1	Herring (*Clupea harengus*)		69.03	30.97	18.46	11.01	1.50	3.06
1	King-fish (*Menticirrus nebulosus*)		79.21	20.79	18.66	0.95	1.18	3.03
1	Masquallonge (*Esox nobilior*)		76.26	23.74	19.63	2.54	1.57	3.22
6	Mackerel (*Scomber scombrus*):							
	Maximum		78.67	35.99	19.25	16.30	1.50	3.12
	Minimum		64.01	21.33	17.42	2.20	1.00	2.80
	Average		73.37	26.63	18.26	7.09	1.28	2.99
1	Spanish mackerel (*Cybium maculatum*)		68.10	31.90	20.97	9.43	1.50	3.43
1	Mullet (*Mugil albula*)		74.87	25.13	19.32	4.64	1.17	3.12
2	Pompano (*Trachynotus carolinus*):							
	Maximum		78.18	32.62	19.15	13.51	1.03	3.09
	Minimum		67.38	21.82	18.15	1.64	0.96	2.94
	Average		72.78	27.22	18.65	7.57	1.00	2.02
1	Pike perch (*Stizostedium canadensis*)		80.85	19.15	17.26	0.76	1.13	2.86
1	Pike perch (*Stizostedium vitreum*)		79.74	20.26	18.42	0.47	1.37	2.97

2	White perch (*Morone americana*), average	--	75.71	24.29	19.03	4.07	1.19	3.08
2	Yellow perch (*Perca fluviatilis*), average		79.25	20.75	18.68	0.83	1.24	3.00
1	Pickerel (*Esox lucius*)		79.79	20.21	18.60	0.58	1.03	2.99
2	Pickerel (*Esox reticulatus*), average		79.68	20.32	18.64	0.50	1.18	3.00
1	Pollock (*Pollachius carbonarius*)		76.02	23.98	21.65	0.78	1.55	3.46
3	Porgy (*Stenotomus argyrops*):							
	Maximum		79.68	28.02	19.29	7.86	1.40	3.11
	Minimum		71.98	20.32	17.46	1.46	1.35	2.78
	Average		74.99	25.01	18.52	5.11	1.38	2.97
2	Red snapper (*Lutjanus blackfordii*), average		78.58	21.42	18.85	1.24	1.33	3.12
3	Maine salmon (*Salmo salar*):							
	Maximum		67.15	38.97	24.45	13.07	1.45	3.96
	Minimum		61.03	32.85	19.17	12.47	1.21	3.14
	Average		63.18	36.82	22.62	12.86	1.34	3.68
1	California salmon (*Oncorhynchus chouicha*)		64.53	35.47	17.96	16.50	1.01	2.85
7	Shad (*Alosa sapidissima*):							
	Maximum		73.56	34.75	19.98	13.59	1.54	3.21
	Minimum		65.25	26.44	17.83	6.51	0.90	2.89
	Average		70.62	29.38	18.56	9.47	1.35	3.01
1	Skate (*Raia?*)		82.15	17.85	15.32	1.39	1.14	2.91
2	Sheepshead (*Archosargus probatocephalus*):							
	Maximum		79.68	27.99	20.15	6.72	1.33	3.33
	Minimum		72.01	20.92	18.93	0.66	1.10	3.10
	Average		75.55	24.45	19.54	3.69	1.22	3.22
2	Smelt (*Osmerus mordax*), average		79.16	20.84	17.37	1.79	1.68	2.81
1	Sturgeon (*Acipenser sturio*)		78.71	21.29	17.96	1.90	1.43	2.90
1	Tom-cod (*Microgadus tomcodus*)		81.55	18.45	17.08	0.38	0.99	2.76
2	Salmon trout, "Mackinaw trout" (*Cristivomer namaycush*), average		69.14	30.86	18.34	11.26	1.26	2.97
3	Brook trout (*Salvelinus fontinalis*):							
	Maximum		79.84	24.22	20.03	2.94	1.42	3.25
	Minimum		75.78	20.16	18.43	0.75	0.96	2.98
	Average		77.72	22.28	18.97	2.10	1.21	3.08
1	White-fish (*Coregonus clupeiformis*)		69.83	30.17	22.06	6.49	1.62	3.67
1	Weak fish (*Cynoscion regalis*)		78.97	21.03	17.45	2.39	1.19	2.85
	ROE.							
1	Shad roe		71.25	28.75	20.88	3.78	1.53	3.34
	SPENT FISH.							
2	Salmon (*Salmo salar*):							
	Maximum		78.20	24.73	19.24	4.37	1.17	3.06
	Minimum		75.27	21.80	17.80	2.83	1.12	2.82
	Average		76.74	23.26	18.52	3.60	1.14	2.94
2	Salmon, land-locked (*Salmo salar* subsp. *sebago*), average		78.54	21.46	17.24	2.98	1.24	2.68
	PRESERVED FISH.							
	DRIED.							
1	Cod, boned, steam-dried, and ground (*Gadus morrhua*)	2.88	15.25	81.87	74.56	1.90	5.41	12.48
	SALTED.							
1	Mackerel (*Scomber scombrus*)	10.60	42.19	47.21	22.05	22.59	2.57	3.38

TABLE IV.—*Percentages of water and nutritive ingredients, &c.*—Continued.

Number of specimens analyzed.	Kinds of fish.	Salt.	In flesh, edible portion.					
			Water	Water-free substance (total nutrients).	Ingredients of water-free substance, nutrients.			Nitrogen.
					Albumenoids by difference.	Fats.	Mineral matters.	
	SALTED AND DRIED.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
2	Cod (*Gadus morrhua*), average	20.58	53.58	25.84	21.42	0.34	4.08	4.06
1	Cod, boned (*Gadus morrhua*)	19.13	54.35	26.52	22.12	0.32	4.08	4.20
1	Cod, boned, steam-dried, and ground (*Gadus morrhua*)	6.60	11.65	81.75	71.62	4.89	5.24	11.52
	SALTED, SMOKED, AND DRIED.							
1	Haddock, "Findon haddie" (*Melanogrammus æglefinus*)	2.06	72.56	25.38	23.68	0.17	1.53	3.73
2	Halibut (*Hippoglossus americanus*):							
	Maximum	13.05	51.06	39.43	23.00	15.61	2.13	3.68
	Minimum	12.87	47.70	35.89	18.15	14.44	1.99	2.96
	Average	12.96	49.38	37.66	20.57	15.03	2.06	3.32
1	Herring (*Clupea harengus*)	11.66	34.55	53.79	36.44	15.82	1.53	5.91
	CANNED.							
1	Mackerel (*Scomber scombrus*)	1.93	68.18	29.89	19.91	8.68	1.30	3.14
2	Mackerel, salted (*Scomber scombrus*), average	10.30	43.43	46.27	17.28	26.39	2.60	2.76
3	Salmon (*Oncorhynchus chouicha*):							
	Maximum	2.19	65.86	42.04	21.29	21.49	1.35	3.37
	Minimum	0.41	57.55	33.61	19.20	11.06	1.26	3.12
	Average	1.30	59.89	38.81	19.44	18.02	1.35	3.16
1	Sardines (*Clupea pilchardus?*)	.....	56.37	43.63	25.31	12.71	5.61	3.98
1	Tunny, "Horse-mackerel" (*Orcynus secundo-dorsalis?*)	9.44	43.23	47.33	16.86	27.94	2.53	2.65
1	"Findon haddie", smoked haddock (*Melanogrammus æglefinus*)	5.59	68.73	25.68	21.78	2.25	1.65	3.58

Table V.—*Percentages of refuse, water, and nutritive ingredients in specimens of American food-fishes as found in the markets.*

Number of specimens.	Kind of fish and portion taken for analysis.	Maximum, minimum, or average.	Salt.	Refuse (bones, skin, entrails, &c.).	Edible portion (flesh).	Flesh, edible portion. Water.	Flesh, edible portion. Water-free substance (nutrients).	Nutrients. Protein (albuminoids).	Nutrients. Fats.	Nutrients. Ash, mineral matters.
	Fresh Fish.			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*P. ct.*
1	Alewife (*Pomolobus vernalis*), whole			49.4	50.6	36.9	13.7	9.9	3.0	0.8
2	Black bass (*Micropterus pallidus*), whole	Average		54.8	45.2	34.6	10.6	9.2	0.8	0.6
1	Red bass (*Sciænops ocellatus*), whole			63.5	36.5	29.8	6.7	6.1	0.2	0.4
1	Sea bass (*Centropristis atrarius*), whole			56.1	43.9	34.8	9.1	8.3	0.2	0.6
	Striped bass (*Roccus lineatus*):									
5	Whole	Average		54.9	45.1	35.1	10.0	8.3	1.3	0.4
1	Entrails removed			51.2	48.8	37.4	11.4	8.7	2.2	0.5
	Blackfish (*Tautoga onitis*):									
2	Whole	Average		60.2	39.8	31.5	8.3	7.4	0.5	0.4
2	Entrails removed	Average		55.7	44.3	35.0	9.3	8.2	0.6	0.5
1	Bluefish (*Pomatomus saltatrix*), entrails removed			48.6	51.4	40.3	11.1	9.8	0.6	0.7
1	Buffalo-fish (*Myxostoma celata*), entrails removed			52.5	47.5	37.3	10.2	8.5	1.1	0.6
1	Butter-fish (*Poronotus triacanthus*), whole			42.8	57.2	40.1	17.1	10.2	6.3	0.6
1	Ciscoe (*Argyrosomus tullibee*), whole			42.7	57.3	43.6	13.7	11.0	2.0	0.7
	Cod (*Gadus morrhua*):									
2	Whole	Average		52.5	47.5	39.2	8.8	7.5	0.2	0.6
3	Head and entrails removed	Average		29.9	70.1	57.9	12.2	11.0	0.3	0.9
1	Cusk (*Brosmius brosme*), entrails removed			40.3	59.7	49.0	10.7	10.1	0.1	0.5
1	Lamprey eel (*Petromyzon marinus*), whole			45.8	54.2	38.5	15.7	8.1	7.2	0.4
2	Eel (*Anguilla rostrata*), skin, head, and entrails removed	Average		20.2	79.8	57.1	22.7	14.6	7.3	0.8
	Flounder (*Paralichthys dentatus*):									
1	Entrails removed			57.0	43.0	35.8	7.2	6.3	0.3	0.6
1	Whole			66.8	33.2	27.2	6.0	5.2	0.3	0.5
1	Flounder (*Pseudopleuronectes americanus*), whole			56.2	43.8	37.0	6.8	6.1	0.2	0.5
2	Red grouper (*Epinephelus morio*), entrails removed	Average		55.8	44.2	35.1	9.1	8.3	0.3	0.5
4	Haddock (*Melanogrammus æglefinus*), entrails removed	Average		51.0	49.0	40.0	9.0	8.3	0.1	0.6
1	Hake (*Phycis chuss*), entrails removed			52.5	47.5	39.5	8.0	7.2	0.3	0.5
	Halibut (*Hippoglossus americanus*):									
	Sections of body	Maximum		23.1	88.8	62.6	26.5	16.1	9.4	1.0
	Sections of body	Minimum		11.2	76.9	60.9	16.0	13.4	1.7	0.7
3	Sections of body	Average		17.7	82.3	62.1	20.2	15.1	4.2	0.9
1	Herring (*Clupea harengus*), whole			46.0	54.0	37.3	16.7	10.0	5.9	0.8
1	Kingfish (*Menticirrus nebulosus*), whole			56.6	43.4	34.4	9.0	8.1	0.4	0.5
1	Masquallonge (*Esox nobilior*), whole			49.2	50.8	38.7	12.1	10.0	1.3	0.8

Table V.—*Percentages of refuse, water, and nutritive ingredients in specimens of American food-fishes as found in the markets*—Continued.

Number of specimens.	Kind of fish and portion taken for analysis.	Maximum, minimum, or average.	Salt.	Refuse (bones, skin, entrails, &c.).	Edible portions (flesh).	Flesh, edible portion. Water.	Water-free substance (nutrients).	Nutrients. Protein (albuminoids).	Fats.	Ash, mineral matters.
	FRESH FISH—Continued.									
	Mackerel (*Scomber scombrus*):			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	P. ct.
	Whole	Maximum		51.8	66.2	48.5	23.8	12.1	10.7	1.0
	Whole	Minimum		33.8	48.2	35.8	12.4	8.4	1.4	0.6
5	Whole	Average		44.6	55.4	40.7	14.7	10.1	3.9	0.7
1	Entrails removed			40.7	59.3	43.7	15.6	11.4	3.5	0.7
1	Spanish mackerel (*Cybium maculatum*), whole			34.6	65.4	44.5	20.9	13.7	6.2	1.0
1	Mullet (*Mugil albula*), whole			57.9	42.1	31.5	10.6	8.1	2.0	0.5
2	Pompano (*Trachynotus carolinus*), whole	Average		45.5	54.5	39.5	15.0	10.2	4.3	0.5
1	Pike perch (*Stizostedium canadensis*), whole			63.2	36.8	29.7	7.1	6.4	0.3	0.4
1	Pike perch (*Stizostedium vitreum*), whole			57.2	42.8	34.1	8.7	7.9	0.2	0.6
2	White perch (*Morone americana*), whole	Average		62.5	37.5	28.3	9.2	7.2	1.5	0.5
	Yellow perch (*Perca fluviatilis*):									
1	Whole			62.7	37.3	30.0	7.3	6.7	0.2	0.4
1	Entrails, &c., removed			35.1	64.9	50.7	14.2	12.6	0.7	0.9
1	Pickerel (*Esox lucius*), whole			42.7	57.3	45.7	11.6	10.7	0.3	0.6
2	Pickerel (*Esox reticulatus*), whole	Average		47.0	53.0	42.2	10.8	9.9	0.2	0.7
1	Pollock (*Pollachius carbonarius*), head and entrails removed			28.5	71.5	54.3	17.2	15.5	0.6	1.1
3	Porgy (*Stenotomus argyrops*)	Average		60.0	40.0	30.0	10.0	7.4	2.0	0.6
2	Red snapper (*Lutjanus blackfordii*), entrails removed	Average		48.9	51.1	40.3	10.8	9.6	0.6	0.6
	Salmon (*Salmo salar*):									
1	Entrails, &c., removed			23.8	76.2	51.2	25.0	14.6	9.5	0.9
2	Whole	Average		38.5	61.5	37.6	23.9	15.0	8.0	0.9
1	California salmon (*Oncorhynchus chouicha*), sections of body			10.3	89.7	57.9	31.8	16.1	14.8	0.9
	Shad (*Alosa sapidissima*):									
	Whole	Maximum		58.8	55.6	39.5	18.6	10.5	7.3	0.8
	Whole	Minimum		44.4	41.2	30.3	10.9	7.4	2.9	0.5
7	Whole	Average		50.1	49.9	35.2	14.7	9.3	4.7	0.7
1	Skate (*Raia ?*), left lobe of body			51.0	49.0	40.2	8.8	7.5	0.7	0.6
	Sheepshead (*Archosargus probatocephalus*):									
1	Entrails removed			56.5	43.5	31.3	12.2	8.8	2.9	0.5
1	Whole			66.0	34.0	26.9	7.1	6.4	0.2	0.5
2	Smelt (*Osmerus mordax*), whole	Average		41.9	58.1	46.1	12.0	10.0	1.0	1.0
1	Sturgeon (*Acipenser sturio*), sections of body			14.4	85.6	67.4	18.2	15.4	1.6	1.2
1	Tom-cod (*Microgadus tomcodus*), whole			59.9	40.1	32.7	7.4	6.8	0.2	0.4

	Salmon trout (*Salvelinus namaycush*):									
1	Whole	....	....	56.3	43.7	30.0	13.7	7.7	5.4	0.6
1	Entrails removed	....	....	35.2	64.8	45.0	19.8	12.4	6.6	0.8
3	Brook trout (*Salvelinus fontinalis*), whole	Average	....	48.1	51.9	40.3	11.6	9.9	1.1	0.6
1	Whitefish (*Coregonus clupeiformis*), whole	....	....	53.5	46.5	32.5	14.0	10.3	3.0	0.7
1	Weakfish (*Cynoscion regalis*), whole	....	....	51.9	48.1	38.0	10.1	8.4	1.1	0.6
	SPENT FISH.									
2	Salmon (*Salmo salar*), whole	Average	....	43.6	56.4	43.3	13.1	10.4	2.1	0.6
2	Land-locked salmon (*Salmo salar*, subsp. *sebago*), whole	Average	....	47.3	52.7	41.4	11.3	9.1	1.6	0.6
	PRESERVED FISH.									
	DRIED.									
1	Dried cod (*Gadus morrhua*), flesh desiccated and ground	....	2.9	....	97.1	15.2	81.9	74.6	1.9	5.4
	SALTED.									
1	Salt mackerel (*Scomber scombrus*)	....	8.2	22.9	68.9	32.5	36.4	17.0	17.4	2.0
	SALTED AND DRIED.									
2	Salt cod (*Gadus morrhua*)	Average	15.4	24.9	59.7	40.3	19.4	16.0	0.4	3.0
1	Salt cod (*Gadus morrhua*), boned	....	19.1	....	80.9	54.4	26.5	22.1	0.3	4.1
	SALTED, SMOKED, AND DRIED.									
1	Smoked haddock, "Findon haddie" (*Melanogrammus æglefinus*)	....	1.4	32.2	66.4	49.2	17.2	16.1	0.1	1.0
2	Smoked halibut (*Hippogolossus americanus*)	Average	12.0	7.0	81.0	45.9	35.1	19.2	14.0	1.9
1	Smoked herring (*Clupea harengus*)	....	6.5	44.4	49.1	19.2	29.9	20.2	8.8	0.9
	CANNED.									
	Mackerel (*Scomber scombrus*)	....	1.9	....	98.1	68.2	29.9	19.9	8.7	1.3
2	Canned salmon (*Oncorhynchus chouicha*)	Average	1.3	....	98.7	59.9	38.8	19.4	18.8	1.3
	Sardines (*Clupea pilchardus ?*)	....	....	5.0	95.0	53.6	41.4	24.0	12.1	5.3
	Tunny, "Horse mackerel" (*Orcynus secundo-dorsalis ?*)	....	....	....	100.0	72.7	27.3	21.5	4.1	1.7
2	Salt mackerel (*Scomber scombrus*)	Average	8.3	19.7	72.0	34.8	37.2	13.8	21.3	2.1
	"Findon haddie," smoked haddock (*Melanogrammus æglefinus*)	....	5.6	....	94.4	68.7	25.7	21.8	2.3	1.6

TABLE VI.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food.*

Laboratory number of specimen.	Name and locality of specimen.	Specimen received.	Edible portion. In flesh. Water.	In flesh. Nitrogen.	In flesh. Protein. Nitrogen × 6.25.	In flesh. Fat. Ether extract.	In flesh. Crude ash.	In liquids. Water.	In liquids. Nitrogen.	In liquids. Protein. Nitrogen × 6.25.	In liquids. Fat. Ether extract.	In liquids. Crude ash.	In edible portion. Flesh plus liquids. Water.	Water-free substance.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Extractives.	Nitrogen.	In whole sample.* Total edible portion.	Total water-free substance, actual nutrients.
	OYSTERS, *Ostrea virginiana* (in shell).		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
68	Buzzard's Bay, Massachusetts	May, '81	84.21	1.24	7.75	1.57	1.48	96.40	0.20	1.23	0.00	1.63	88.80	11.20	5.30	0.99	1.54	3.37	0.85	20.01	2.22
70	Providence River, Rhode Island	May, '81	79.01	1.65	10.30	2.58	2.13	95.05	0.24	1.48	0.00	2.41	84.79	15.21	7.12	1.65	2.23	4.21	1.14	17.00	2.59
103	Clinton, Conn	Nov., '81	80.91	1.55	9.67	1.86	2.29	96.02	0.18	1.10	0.02	2.21	88 91	11.09	5.13	0.88	2.24	2.84	0.82	24.87	2.76
55	Stony Creek, Connecticut	Apr., '81	81.02	1.67	10.46	1.60	2.76	96.12	0.13	0.83	0.01	2.72	90.11	9.89	4.64	0.64	2.73	1.95	0.74	18.90	1.89
75	......do	May, '81	82.09	1.57	9.81	1.48	2.55	96.33	0.10	0.63	0.05	2.61	90.89	9.11	4.19	0.60	2.59	1.73	0.67	19.15	1.75
105	......do	Nov., '81	77.82	1.70	10.60	2.32	2.51	95.40	0.22	1.36	0.01	2.33	84.83	15.17	6.94	1.39	2.44	4.40	1.11	18,23	2.76
203	......do	Mar., '82	80.42	1.66	10.38	1.85	2.22	95.30	0.23	1.42	0.03	2.50	87.19	12.81	6.31	1.02	2.34	3.14	1.01	20.50	2.62
	Average of 4 samples	....	80.34	1.65	10.33	1.81	2.51	95.79	0.17	1.06	0.02	2.54	88.24	11.76	5.52	0.91	2.52	2.80	0.88	19.20	2.26
54	Fair Haven, Conn	Apr., '81	81.30	1.58	9.89	2.05	2.20	94.00	0.33	2.06	0.02	3.19	85.12	14.88	7.53	1.44	2.50	3.41	1.20	18.06	2.69
93	......do	Nov., '31	76.24	1.75	10.96	2.47	2.01	94.43	0.34	2.14	0.02	2.43	85.25	14.75	6.24	1.26	2.22	5.03	1.00	24.31	3.59
210	......do	Mar., '82	80.80	1.58	9.89	2.05	1.85	95.12	0.31	1.94	0.03	2.21	84.64	15.36	7.75	1.28	2.92	3.81	1.24	16.59	2.55
	Average of 3 samples	....	79.44	1.64	10.25	2.19	2.02	94.52	0.33	2.06	0.02	2.61	85.00	15.00	7.17	1.33	2.54	4.08	1.12	19.65	2.95
118	Norwalk, Conn	Dec., '81	81.33	1.52	9.52	1.51	2.10	96.46	0.12	0.75	0.01	2.32	90.04	9.90	4.50	0.65	2.23	2.52	0.72	17.85	1.78
151	......do	Feb., '82	80.50	1.60	9.97	1.89	2.15	96.32	0.12	0.76	0.02	2.50	89.60	10.40	4.69	0.82	2.35	2.54	0.75	17.05	1.77
	Average of 2 samples	....	80.92	1.56	9.75	1.70	2.13	96.39	0.12	0.77	0.02	2.41	89.82	10.18	4.59	0.73	2.29	2.51	0.73	17.45	1.78
56	Blue Point, New York	Apr., '81	76.77	1.61	10.06	2.30	1.93	94.33	0.37	2.31	0.09	1.91	81.70	18.30	8.22	1.72	1.92	6.46	1.31	18.62	3.41
107	.... do	Nov., '81	75.55	2.13	13.31	2.02	2.58	96.89	0.12	0.75	0.01	1.90	88.30	11.70	5.81	0.82	2.17	2.90	0.93	16.17	1.95

182	......do....	Feb., '82	83.97	1.41	8.81	1.62	1.59	96.87	0.15	0.92	0.01	1.70	90.15	9.85	5.00	0.85	1.64	2.36	0.80	15.42	1.52
	Average of 3 samples	....	78.76	1.72	10.73	1.98	2.03	96.03	0.21	0.31	0.04	1.88	86.75	13.28	6.34	1.13	1.91	3.91	1.01	16.74	2.38
58	Rockaway, New York..............	Apr., '81	81.27	1.47	9.18	2.13	1.67	95.06	0.26	1.60	0.04	2.26	87.06	12.94	6.00	1.25	1.92	3.85	0.96	18.40	2.40
112	......do............................	Nov., '81	77.66	1.68	10.53	2.72	2.02	94.79	0.28	1.76	0.01	2.56	84.31	15.69	7.06	1.66	2.23	4.74	1.13	19.84	3.13
	Average of 2 samples	....	79.46	1.58	9.85	2.43	1.85	94.92	0.27	1.68	0.03	2.40	85.65	14.35	6,53	1.46	2.07	4.29	1.01	19.12	2.75
60	Long Island Sound, New York......	Apr., '81	84.47	1.30	8.14	1.68	1.41	96.35	0.21	1.30	0.09	0.85	89.67	10.33	5.24	0.98	1.17	3.03	0.84	16.23	1.69
92	.... do........	Nov., '81	78.51	1.86	11.61	1.84	2.52	93.81	0.37	2.29	0.02	3.16	83.64	16.36	8.50	1.23	2.73	3.90	1.36	14.62	2.39
109	... .do............................	Nov., '81	82.79	1.35	8.41	1.74	1.71	96.64	0.18	1.09	0.01	1.87	90.15	9.85	4.56	0.82	1.79	2.68	0.73	17.59	1.73
	Average of 3 samples	....	81.92	1.50	9.39	1.75	1.88	95.60	0.25	1.56	0.04	1.96	87.79	12.21	6.10	1.01	1.89	3.20	0.98	16.15	1.97
180	Oyster Bay, New York..............	Feb., '82	77.90	1.70	10.61	2.35	2.19	95.31	0.23	1.46	0.01	2.37	84.34	15.66	7.19	1.48	2.26	4.73	1.15	17.27	2.70
57	East River, New York..............	Apr., '81	79.92	1.67	10.44	2.16	1.74	95.44	0.26	1.63	0.02	1.57	87.57	12.43	6.31	1.10	1.87	3.15	1.01	20.28	2.52
108	......do............................	Nov., '81	75.22	1.61	10.07	2.87	1.87	94.87	0.29	1.81	0.09	2.33	83.35	16.65	6.39	1.72	2.06	6.48	1.02	20.31	3.38
	Average of 2 samples	....	77.57	1.64	10.25	2.52	1.81	95.16	0.27	1.74	0.06	1.95	85.46	14.54	6.35	1.41	1.97	4.82	1.02	20.30	2.87
61	Shrewsbury, New Jersey	Apr., '81	81.65	1.31	8.20	2.20	1.33	95.07	0.33	2.06	0.04	1.83	85.37	14.63	6.48	1.60	1.47	5.08	1.04	17.52	2.56
106	......do	May, '81	77.58	1.55	9.68	2.66	1.88	95.35	0.30	1.88	0.04	1.96	85.17	14.83	6.24	1.54	1.91	5.14	1.00	19.67	2.93
181	......do...	Nov., '82	81.73	1.46	9.13	2.00	1.68	96.52	0.22	1.38	0.01	1.72	89.16	10.84	4.87	1.00	1.70	3.27	0.78	19.23	2.08
	Average of 3 samples	....	80.32	1.44	9.00	2.29	1.63	95.65	0.28	1.76	0.03	1.83	86.57	13.43	5.88	1.38	1.69	4.49	0.94	18.81	2.53
59	Norfolk, Va	Apr., '81	83.86	1.49	9.32	1.45	1.82	96.83	0.17	1.05	0.01	1.64	91.45	8.55	4.50	0.61	1.71	1.73	0.72	11.18	0.95
73	Potomac River, Va. (transplanted)†..	May, '81	78.87	1.57	9.81	2.27	2.54	95.51	0.23	1.42	0.01	2.47	86.60	13.40	5.92	1.22	2.51	3.75	0.95	12.15	1.63
84	......do.†	Nov., '81	82.06	1.45	9.06	1.93	1.58	95.69	0.33	2.05	0.01	1.19	87.36	12.64	6.25	1.18	1.43	3.78	1.00	16.66	2.11
85	......do.†	Nov., '81	77.90	1.65	10.31	2.33	2.17	94.99	0.29	1.81	0.02	2.47	86.14	13.86	6.19	1.21	2.31	4.15	0.99	16.13	2.23
	Average of 3 samples	....	79.61	1.56	9.74	2.18	2.10	95.40	0.28	1.76	0.01	2.04	86.70	13.30	6.12	1.20	2.08	3.89	0.98	14.98	2.00
72	Rappahannock River, Virginia (transplanted)	May, '81	82.64	1.36	8.49	1.90	1.58	97.24	0.16	1.01	0.01	1.38	89.77	10.23	4.88	0.99	1.52	2.73	0.78	15.17	1.53
71	James River, Va. (transplanted)† ...	May, '81	83.49	1.32	8.26	1.78	1.71	95.91	0.19	1.17	0.01	2.56	90.05	9.95	4.63	0.84	2.16	2.48	0.74	13.79	1.41
82	......do.†	Nov., '81	77.99	1.70	10.63	2.61	2.21	94.74	0.31	1.95	0.05	2.54	84.15	15.85	7.09	1.67	2.35	4.85	1.12	15.00	2.38
83	......do.†	Nov., '81	82.77	1.40	8.75	1.91	1.55	95.22	0.34	2.14	0.13	1.42	86.95	13.05	8.00	1.31	1.51	2.23	1.28	17.17	2.19
	Average of 3 samples	....	81.42	1.47	9.23	2.10	1.82	95.29	0.28	1.76	0.07	2.17	87.05	12.95	6.54	1.27	2.00	3.19	1.05	15.32	1.98
	Average of 34 samples (average of averages)	......	80.52	1.55	9.04	2.04	1.96	95.76	0.22	1.42	0.03	2.09	87.30	12.70	5.95	1.15	2.03	3.55	0.95	17.70	2.32

* *I. e.*, in sample as received for analysis; in the majority of the cases the whole animal, including both edible portion and shell.

† To New Haven, Conn.

TABLE VI.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food*—Continued.

Laboratory number of specimen.	Name and locality of specimen.	Specimen received.	Edible portion.																	In whole sample.	
			In flesh.					In liquids.					In edible portion. (Flesh plus liquids.)								
			Water.	Nitrogen.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Water.	Nitrogen.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Water.	Nitrogen.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Extractives.	Nitrogen.	Total edible portion.	Total water-free substance, actual nutrients.
			Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
	OYSTERS, "SOLIDS" (out of shell).*																				
89	Fair Haven, Conn	Nov., '81	84.04	1.14	7.12	1.96	0.86	96.19	0.26	1.60	0.02	0.55	85.21	14.79	6.60	1.77	0.83	5.59	1.05	100.00	14.79
204	......do	Mar., '82				.....		......	......	......			88.44	11.56	5.91	1.54	0.89	3.22	0.95	100.00	11.56
104	Virginia (transplanted) †	Nov., '81	85.50	1.20	7.51	1.83	1.12	96.43	0.23	1.43	0.02	0.77	87.23	12.77	6.38	1.54	1.06	3.79	1.02	100.00	12.77
202	......do. †	Mar., '82	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	87.90	12.10	6.44	1.57	0.77	3.63	1.03	100.00	12.10
	Average of 4 samples "solids"	....	...	....	.....	.....	.....	.....	....	.....	.....	..	87.19	12.81	6.33	1.60	0.89	4.07	1.01	100.00	12.81
	OYSTERS, "COVE" (canned).																				
74	Chesapeake Bay	May, '81	78.53	2.24	14.00	3.78	1.60	93.57	0.28	1.77	0.27	1.21	86.01	13.99	7.89	2.04	1.42	2.51	1.26	100.00	13.99
97	......do	Nov., '81	76.75	2.12	13.25	4.35	1.63	93.35	0.22	1.40	0.09	0.91	85.14	14.96	7.25	2.19	1.27	4.25	1.16	100.00	14.96
120	......do	Nov., '81	77.25	2.15	13.44	4.24	1.45	90.57	0.30	1.88	0.12	1.10	84.60	15.40	7.00	1.96	1.26	5.18	1.12	100.00	15.40
	Average of 3 samples	....	77.51	2.17	13.46	4.12	1.56	92.50	0.27	1.70	0.16	1.08	85.25	14.78	7.38	2.06	1.32	3.98	1.18	100.00	14.78
	SCALLOPS, *Pecten irradians.*																				
51	Shelter Island, New York	Mar., '81	.....	....	.....	.....	.....	.....	.....	.....	.....	....	77.79	22.21	15.05	0.03	1.48	5.65	2.41	100.00	22.21
63	......do	Apr., '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	82.84	17.16	14.44	0.30	1.29	1.13	2.31	100.00	17.16
	Average of 2 samples	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80.32	19.68	14.75	0.17	1.38	3.38	2.36	100.00	19.68
	LONG CLAMS, *Mya arenaria* (in shell).																				
67	Boston, Mass	May, '81	77.96	2.33	14.55	1.79	2.76	95.73	0.08	0.49	0.01	3.29	86.11	13.89	8.13	0.98	3.00	1.78	1.30	53.90	7.50

102	**Clinton, Conn**	Nov., '81	78.57	2.38	14.86	1.78	2.49	96.02	0.11	0.69	0.00	2.81	86.11	13.89	8.69	1.01	2.63	1.56	1.39	57.92	8.05
201	......do	Mar., '82	79.94	2.02	12.62	1.69	3.11	96.77	0.11	0.69	0.01	2.05	85.00	15.00	7.60	1.18	2.79	3.43	1.22	56.30	8.45
	Average of 2 samples		79.26	2.20	13.74	1.74	2.80	96.40	0.11	0.66	0.01	2.43	85.56	14.44	8.15	1.09	2.71	2.49	1.30	57.11	8.25
65	Long Island, New York	Apr., '81	81.05	2.00	12.52	1.52	1.56	94.76	0.21	1.30	0.03	2.93	86.05	13.95	8.40	0.97	2.06	2.52	1.34	57.64	8.04
	Average of 4 samples (average of averages)		79.42	2.18	13.63	1.68	2.37	95.63	0.13	0.82	0.02	2.88	85.91	14.09	8.23	1.01	2.59	2.29	1.31	56.44	8.17
	LONG CLAMS (canned).																				
122	Penobscot Bay, Maine	Nov., '81	74.63	2.87	17.94	2.92	3.18	91.92	0.39	2.44	0.04	1.72	84.54	15.46	9.06	1.27	2.34	2.79	1.45	100.00	15.46
	ROUND CLAMS, *Venus mercenaria* (in shell).																				
66	Little Neck, New York	Apr., '81	78.24	1.86	11.59	0.74	2.22	95.12	0.14	0.88	0.02	3.17	86.20	13.80	6.56	0.40	2.67	4.17	1.05	31.71	4.[illegible]
	ROUND CLAMS (canned).																				
125	Islip, Long Island, N. Y	Nov., '81	75.56	2.67	16.70	1.27	2.33	90.52	0.65	4.07	0.26	3.26	82.91	17.59	9.54	0.68	3.74	3.13	1.53	100.00	17.[illegible]
	MUSSELS, *Mytilus edulis* (in shell).																				
139	Stony Creek, Connecticut	Dec., –	78.67	2.00	12.51	1.67	1.73	94.23	0.28	1.77	0.13	2.25	34.16	15.84	8.69	1.12	1.91	4.12	1.39	50.66	8.[illegible]2
	LOBSTER, *Homarus americanus* (in shell).																				
50	Maine	Mar., '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	84.30	15.70	11.63	1.82	1.63	0.62	1.86	52.52	8.24
62	..... do	Apr., '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	81.77	18.23	14.00	1.55	1.71	0.92	2.24	36.24	6.30
239	.. do	Apr., '82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79.17	20.83	17.24	1.45	1.62	0.52	2.76	.....	.....
69	Massachusetts	May, '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	82.11	17.89	15.03	2.54	1.87	.....	2.41	30.56	5.47
	Average of 4 samples		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	81.84	18.16	14.49	1.84	1.71	....	2.32	39.77	6.80
	LOBSTER (canned).																				
76	Maine	May, '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79.36	20.64	16.75	0.46	2.78	0.65	2.68	100.00	20.64
121	......do	Nov., '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	76.15	23.85	19.52	1.68	2.15	0.50	3.12	100.00	23.85
	Average of 2 samples		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77.75	22.25	18.13	1.07	2.47	0.58	2.90	100.00	22.25
	CRAYFISH (in shell).																				
64	Potomac River, Virginia	Apr., '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	81.22	18.78	16.00	0.46	1.31	1.01	2.56	12.30	2.[illegible]
	CRAB, *Ballinectes hastatus* (in shell).																				
101	New Jersey	Nov., '81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	77.07	22.93	16.64	1.96	3.13	1.20	2.66	44.16	10.12

I. e., shell-contents, including flesh and liquids.

† To New Haven, Conn.

TABLE VI.—*Percentages of water and nutritive ingredients in specimens of American invertebrates used for food*—Continued.

Laboratory number of specimen.	Name and locality of specimen.	Specimens received.	Edible portion.																	In whole sample.	
			In flesh.					In liquids.					In edible portion. (Flesh plus liquids.)								
			Water.	Nitrogen.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Water.	Nitrogen.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Water.	Nitrogen.	Protein. Nitrogen × 6.25.	Fat. Ether extract.	Crude ash.	Extractives.	Nitrogen.	Total edible portion.	Total water-free substance, actual nutriments.
			Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
	CRABS (canned).																				
124	Hampton, Va	Nov., '81	......	......	......	......	......	......	......	......	......	......	80.98	19.02	15.62	0.79	1.78	0.83	2.50	100.00	19.02
274	......do	Apr., '82	......	......	......	......	......	......	......	......	......	......	78.95	21.05	15.98	2.30	2.10	0.67	2.56	100.00	21.05
	Average of 2 samples	....	......	......	......	......	......	......	......	......	......	......	79.97	20.03	15.80	1.54	1.94	0.75	2.53	100.00	20.04
	SHRIMP (canned).																				
123	Gulf of Mexico	Nov., '81	......	......	......	......	......	......	......	......	......	......	70.80	29.20	25.38	1.00	2.58	0.24	4.06	100.00	29.20
	TERRAPIN (in shell).																				
235	Savannah, Ga	Apr., '82	......	......	......	......	......	......	......	......	......	......	74.47	25.53	21.23	3.47	1.02	......	3.40	20.97	5.36
	GREEN TURTLE, *Chelonia mydas* (in shell).																				
272	Key West, Fla	May, '82	......	......	......	......	......	......	......	......	......	......	79.78	20.22	19.84	0.53	1.20	......	3.17	24.03	4.86

TABLE XI.—*Constituents of animal foods.*

[Italics indicate European analyses; the rest are American.]

Kinds of food materials.	In edible portion (*i. e.*, flesh, &c., freed from bones, shells, and other refuse).						In specimens as purchased in the markets, including both edible portion and refuse.						
			Nutrients.					Edible portion.					
										Nutrients.			
	Water.	Nutrients.	Protein albuminoids.	Fats.	Carbo-hydrates, &c.	Mineral matters.	Refuse (bones, skins, shells, &c.).	Water.	Nutrients.	Protein albuminoids.	Fats.	Carbo-hydrates, &c.	Mineral matters.
MEATS, FRESH.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Beef, side, well fattened	54.6	45.4	17.9	26.5		1.0	19.7	43.8	36.5	14.4	21.3		0.8
Beef, lean, nearly freed from fat	76.0	24.0	21.8	0.9		1.3	0.0	76.0	24.0	21.8	0.9		1.3
Beef, round, rather lean *	66.7	33.3	23.0	9.0		1.3	10.0	60.0	30.0	20.7	8.1		1.2
Beef, sirloin, rather fat*	60.0	40.0	19.0	20.0		1.0	25 0	45.0	30.0	14.3	15.0		0.7
Beef, flank, very fat *	27.3	72.7	12.4	59.6		0.7	12.5	23.9	63.6	10.8	52.2		0.6
Beef liver	69.5	30.5	20.1	5.4	3.5	1.5	0.0	69.5	30.5	20.1	5.4		1.5
Beef tongue	63.8	36.2	17.1	18.1		1.0	15.3	54.0	30.7	14.5	15.3	3.5	0.9
Beef heart	56.8	43.2	15.8	26.3		1.1	6.0	53.4	40.6	14.9	24.8		0.9
Veal, lean	79.8	21.2	19.9	0.8		(0.5)	(?)						
Veal, rather fat	72.3	27.7	18.9	7.5		(1.3)	(?)						
Mutton, side, well fattened	53.6	46.4	16.5	29.0		0.9	20.0	42.9	37.1	13.2	23.2		0.7
Mutton, leg *	61.9	38.1	18.2	19.0		0.9	18.4	40.2	41.4	12.2	28.6		0.6
Mutton, shoulder *	58.6	41.4	18.0	22.4		1.0	16.9	48.7	34.4	15.0	18.6		0.8
Mutton, loin (chops) *	49.3	50.7	14.9	35.1		0.7	16.3	41.3	42.4	12.5	29.3		0.6
MEATS, PREPARED.													
Dried beef	59.5	40.5	29.2	4.5		6.8	6.5	55.5	38.0	27.4	4.2		6.4
Corned beef, rather lean	58.1	41.9	21.4	17.9		3.1	6.2	54.5	39.3	20.1	16.3		2.9
Smoked ham	41.5	58.5	24.0	30.6		3.9	12.4	36.4	51.2	21.0	26.8		3.4
Pork, bacon, salted	10.0	90.0	3.0	80.5		6.5	5.0	9.5	85.5	2.8	76.5		6.2
FOWL.													
Chicken, rather lean	71.5	28.5	25.1	2.0		1.4	41.6	41.8	16.6	14.6	1.2		0.8

* Portions of the side of which analysis is given above.

TABLE XI.—*Constituents of animal foods*—Continued.

Kinds of food materials.	In edible portion (*i. e.*, flesh, &c., freed from bones, shells, and other refuse).						In specimens as purchased in the markets, including both edible portion and refuse.						
			Nutrients.					Edible portion.					
										Nutrients.			
	Water.	Nutrients.	Protein albuminoids.	Fats.	Carbo-hydrates, &c.	Mineral matters.	Refuse (bones, skins, shells, &c.).	Water.	Nutrients.	Protein albuminoids.	Fats.	Carbo-hydrates, &c.	Mineral matters.
FOWL—Continued.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Turkey, medium fatness	65.6	34.4	24.7	8.5	....	1.2	35.4	42.4	22.2	16.0	5.5	....	0.7
Goose fat	38.0	62.0	15.9	45.6	....	0.5	(?)	....	....	....	....	....	....
DAIRY PRODUCTS, EGGS, ETC.													
Cow's milk	87.4	12.6	3.4	3.7	4.8	0.7	0.0	87.4	12.6	3.4	3.7	4.8	0.7
Cow's milk, skimmed	90.7	9.3	3.1	0.7	4.8	0.7	0.0	90.7	9.3	3.1	0.7	4.8	0.7
Cow's milk, buttermilk	90.3	9.7	4.1	0.9	4.0	0.7	0.0	90.3	9.7	4.1	0.9	4.0	0.7
Cow's milk, whey	93.2	6.8	0.9	0.2	5.0	0.7	0.0	93.2	6.8	0.9	0.2	5.0	0.7
Cheese, whole milk*	31.2	68.8	27.1	35.4	2.4	3.9	0.0	31.2	68.8	27.1	35.4	2.4	3.9
Cheese, skimmed milk	41.3	58.7	38.3	6.8	9.0	4.6	0.0	41.3	58.7	38.3	6.8	9.0	4.6
Butter	7.0	93.0	1.0	89.0	....	3.0	0.0	7.0	93.0	1.0	89.0	....	3.0
Butter	14.5	85.5	0.7	83.3	0.6	0.9	0.0	14.5	85.5	0.7	83.3	0.6	0.9
Hens' eggs	73.7	26.3	12.5	12.1	0.6	1.1	11.0	65.6	23.4	11.1	10.8	0.5	1.0
FRESH FISH.													
Flounder, whole	84.2	15.8	13.8	0.7	....	1.3	66.8	27.2	6.0	5.2	0.3	....	0.5
Yellow perch, whole	79.2	20.8	18.7	0.8	....	1.3	62.7	30.0	7.3	6.7	0.2	....	0.4
Haddock, dressed	81.7	18.3	16.8	0.3	....	1.2	51.0	40.0	9.0	8.3	0.1	....	0.6
Black bass, whole	76.7	23.3	20.4	1.7	....	1.2	54.8	34.6	10.6	9.2	0.8	....	0.6
Bluefish, dressed	78.5	21.5	19.0	1.2	....	1.3	48.6	40.3	11.1	9.8	0.6	....	0.7
Pickerel (pike), whole	79.7	20.3	18.6	0.5	....	1.2	47.0	42.2	10.8	9.9	0.2	....	0.7
Brook trout, whole	77.7	22.3	19.0	2.1	....	1.2	48.1	40.3	11.6	9.9	1.1	....	0.6
Smelt, whole	79.2	20.8	17.3	1.8	....	1.7	41.9	46.1	12.0	10.0	1.0	....	1.9
Mackerel, lean, whole	78.7	21.3	18.1	2.2	....	1.0	38.3	48.5	13.2	11.2	1.4	....	0.6
Mackerel, fat, whole	64.0	36.0	18.2	16.3	....	1.5	33.8	42.4	23.8	12.1	10.7	....	1.0
Mackerel, average, whole	73.4	26.6	18.2	7.1	....	1.3	44.6	40.7	14.7	10.1	3.9	....	0.7

Alewife, whole	73.0	27.0	19.5	6.0	....	1.5		49.4		36.9	13.7	9.9	3.0	....	0.8
Cod, dressed	82.6	17.4	15.8	0.4	....	1.2		29.9		57.9	12.2	11.0	0.3	....	0.9
Whitefish, whole	69.8	30.2	22.1	6.5	....	1.6		53.5		32.5	14.0	10.3	3.0	....	0.7
Shad, whole	70.6	29.4	18.5	9.5	....	1.4		50.1		35.2	14.7	9.3	4.7	....	0.7
Herring, whole	69.0	31.0	18.5	11.0	....	1.5		46.0		37.3	16.7	10.0	5.9	....	0.8
Halibut, dressed	75.4	24.6	18.3	5.2	....	1.1		17.7		62.1	20.2	15.1	4.2	....	0.9
Salmon trout, dressed	69.1	30.9	18.3	11.3	....	1.3		35.2		45.0	19.8	12.4	6.6	....	0.8
Eel, dressed	71.6	28.4	18.3	9.1	....	1.0		20.2		57.1	22.7	14.6	7.3	....	0.8
Salmon, in season, whole	61.4	38.6	24.2	13.0	....	1.4		38.5		37.6	23.9	15.0	8.0	....	0.9
Salmon, spent, whole	79.2	20.8	17.6	2.0	....	1.2		46.2		42.6	11.2	9.5	1.0	....	0.7
PREPARED FISH.															
							Salt.		*Salt.*						
Smoked haddock	72.6	25.3	23.6	0.2	....	1.5	2.1	32.2	1.4	49.2	17.2	16.1	0.1	....	1.0
Salt cod	53.6	25.8	21.4	0.3	....	4.1	20.6	24.9	15.4	40.3	19.4	16.0	0.4	....	3.0
Smoked herring	34.5	53.8	36.4	15.8	....	1.6	11.7	44.4	6.5	19.2	29.9	20.2	8.8	....	0.9
Canned salmon	59.9	38.8	19.4	18.0	....	1.4	1.3	00.0	1.3	59.9	38.8	19.4	18.8	....	1.3
Salt mackerel	42.2	47.2	22.0	22.6	....	2.6	10.6	22.9	8.2	32.5	36.4	17.0	17.4	....	2.0
Desiccated cod †	15.2	81.9	74.6	1.9	....	5.4	2.9	00.0	2.9	15.2	81.9	74.6	1.9	....	5.4
INVERTEBRATES, SHELL-FISH, ETC.															
Oysters, best	83.4	16.6	6.4	1.7	6.5	2.0		81.4		15.2	3.4	1.5	0.2	1.3	0.4
Oysters, inferior	91.4	8.6	4.5	0.6	1.8	1.7		88.8		10.2	1.0	0.5	0.1	0.2	0.2
Oysters, average ‡	87.3	12.7	6.0	1.2	3.5	2.0		82.3		15.4	2.3	1.0	0.2	0.6	0.5
Oysters, solids, average §	87.2	12.8	6.3	1.6	4.0	0.9		0.0		87.2	12.8	6.2	1.5	4.1	1.0
Round clams	86.2	13.8	6.6	0.4	4.2	2.6		68.3		27.3	4.4	2.1	0.1	1.3	0.9
Long clams	85.9	14.1	8.5	1.0	2.0	2.6		43.6		48.3	7.9	4.3	0.5	1.3	1.8
Mussels	84.2	15.8	8.7	1.1	4.1	1.9		49.3		42.7	8.0	3.9	0.5	2.1	1.5
Scallops	80.3	19.7	14.7	0.2	3.4	1.4		0.0		80.3	19.7	14.7	0.2	3.4	1.4
Cray-fish	81.2	18.8	16.0	0.5	1.0	1.3		87.7		10.0	2.3	1.9	0.1	0.1	0.2
Lobsters	81.8	18.2	14.5	1.8	0.2	1.7		60.2		33.0	6.8	5.4	0.5	0.2	0.7
Crabs	77.1	22.9	16.6	2.0	1.2	3.1		55.8		34.1	10.1	7.3	0.9	0.5	1.4
Canned oysters	85.2	14.8	7.4	2.1	4.0	1.3		0.0		85.4	14.6	6.4	1.6	5.1	1.5
Canned lobsters	77.7	22.3	18.1	1.1	0.6	2.5		0.0		77.7	22.3	18.1	1.1	0.6	2.5

* New York factory cheese.

† Flesh of codfish freed from bone and artificially dried. "Alden's fresh cod," an article not yet common in the market.

‡ "Inferior," "best," and "average" in respect to the percentage of nutrients in shell contents (edible portion) and in whole oysters, including shells and contents (specimens as found in market).

§ That is, the edible portion as ordinarily purchased in the markets, including the "meats" and most of the liquid portion of the shell contents.

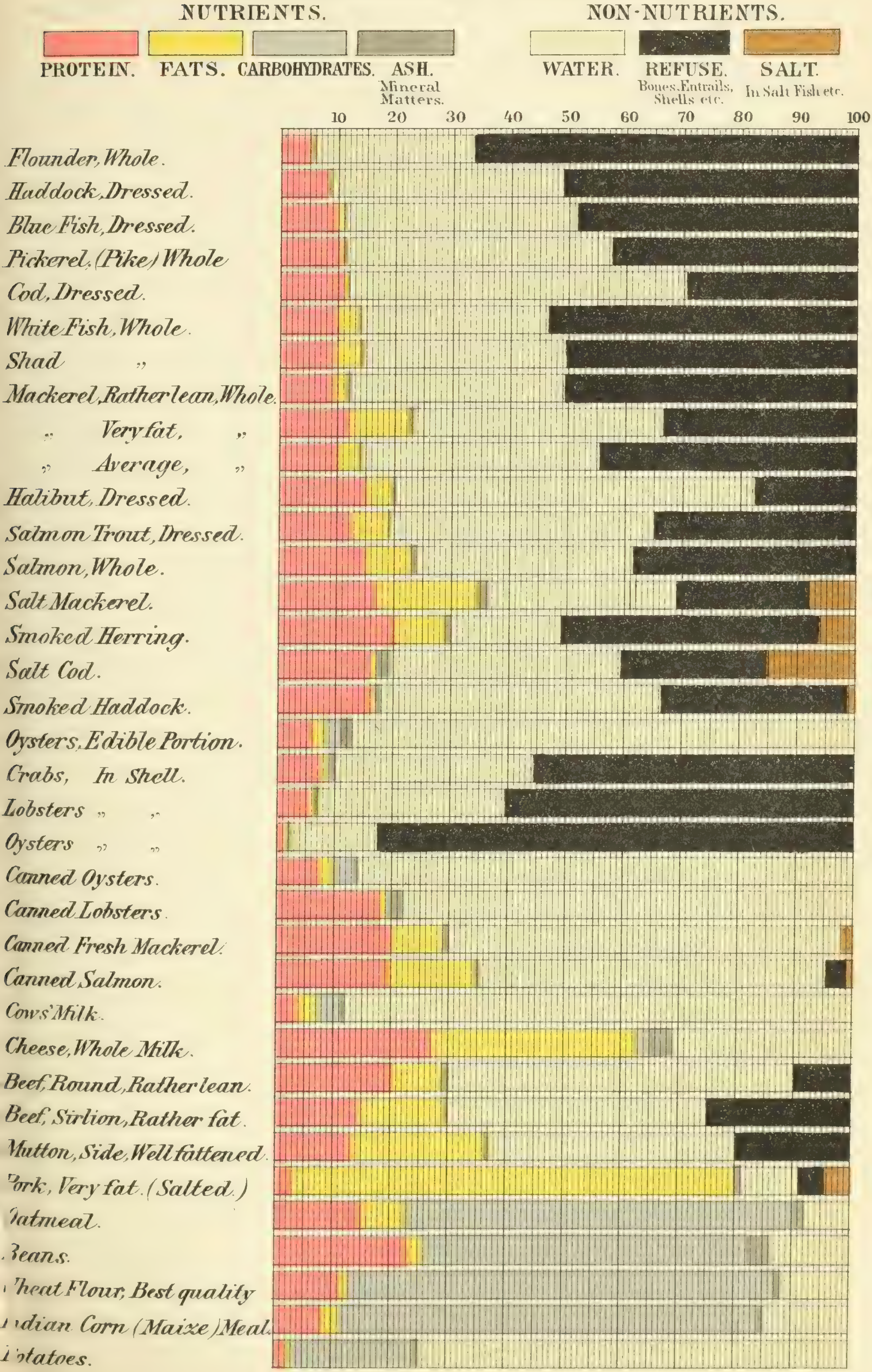
TABLE XII.—*Constituents of vegetable foods and beverages.*

Kinds of foods and beverages.	Water.	Nutrients.				
		Protein (albuminoids).	Fats.	Carbohydrates, &c.	Woody fiber.	Mineral matter.
FOOD.						
Wheat flour, average*	11.6	11.1	1.1	75.4	0.2	0.6
Wheat flour, maximum*	13.5	13.6	2.0	78.5	1.2	1.5
Wheat flour, minimum*	8.3	8.6	0.6	68.3	0.1	0.3
Graham flour (wheat)	13.0	11.7	1.7	69.9	1.9	1.8
Cracked wheat	10.4	11.9	1.7	74.6		1.4
Rye flour	13.1	6.7	0.8	78.3	0.4	0.7
Pearled barley	11.8	8.4	0.7	77.8	0.3	1.0
Buckwheat flour	13.5	6.5	1.3	77.3	0.3	1.1
Buckwheat "farina"	11.2	3.3	0.3	84.7	0.1	0.4
Buckwheat "groats"	10.6	4.8	0.6	83.1	0.3	0.6
Oatmeal	7.7	15.1	7.1	67.2	0.9	2.0
Cornmeal	14.3	8.4	3.5	70.9	1.6	1.3
Hominy	13.5	8.3	0.4	77.1	0.3	0.4
Rice	12.4	7.4	0.4	79.2	0.2	0.4
Beans	13.7	23.2	2.1	53.7	3.7	3.6
Peas	15.0	22.9	1.8	52.4	5.4	2.5
Potatoes	75.5	2.0	0.2	20.7	0.8	1.0
Sweet potatoes	75.8	1.5	0.4	20.0	1.1	1.2
Turnips	91.2	1.0	0.2	6.0	0.9	0.7
Carrots	87.9	1.0	0.2	8.9	1.2	0.8
Cabbage	90.0	1.9	0.2	4.9	1.8	1.2
Cauliflower	90.4	2.5	0.4	5.0	0.9	0.8
Melons	95.2	1.1	0.6	1.4	1.1	0.6
Pumpkins	90.0	0.7	0.1	7.3	1.3	0.6
Apples	84.8	0.4	0.0	12.8	1.5	0.5
Pears	83.0	0.4	0.0	12.0	4.3	0.3
Starch	15.1	1.2	0.0	83.3	0.0	0.4
Cane, sugar	2.2	0.3	0.0	96.7	0.0	0.8
Wheat bread†	32.7	8.9	1.9	55.5		1.0
Graham bread	34.2	9.5	1.4	53.3		1.6
Rye bread	30.0	8.4	0.5	59.7		1.4
Soda crackers	8.0	10.3	9.4	70.5		1.8
"Boston" crackers	8.3	10.7	9.9	68.7		2.4
"Oyster" crackers	3.9	12.3	4.8	76.5		2.5
Oatmeal crackers	4.9	10.4	13.7	69.6		1.4
Pilot (bread) crackers	7.9	12.4	4.4	74.2		1.1
Macaroni	13.1	9.0	0.3	76.8		0.8
BEVERAGES.			Alcohol.		Free acid.	
Lager beer	90.3	0.5	4.0	6.6	......	0.2
Porter and ale	88.5	0.7	5.2	7.2	......	0.3
Rhenish wine, white	86.3	......	10.5	2.6	0.4	0.2
Rhenish wine, red	86.9	......	8.9	3.4	0.5	0.3
French wine, claret	88.4	......	8.1	2.7	0.6	0.2

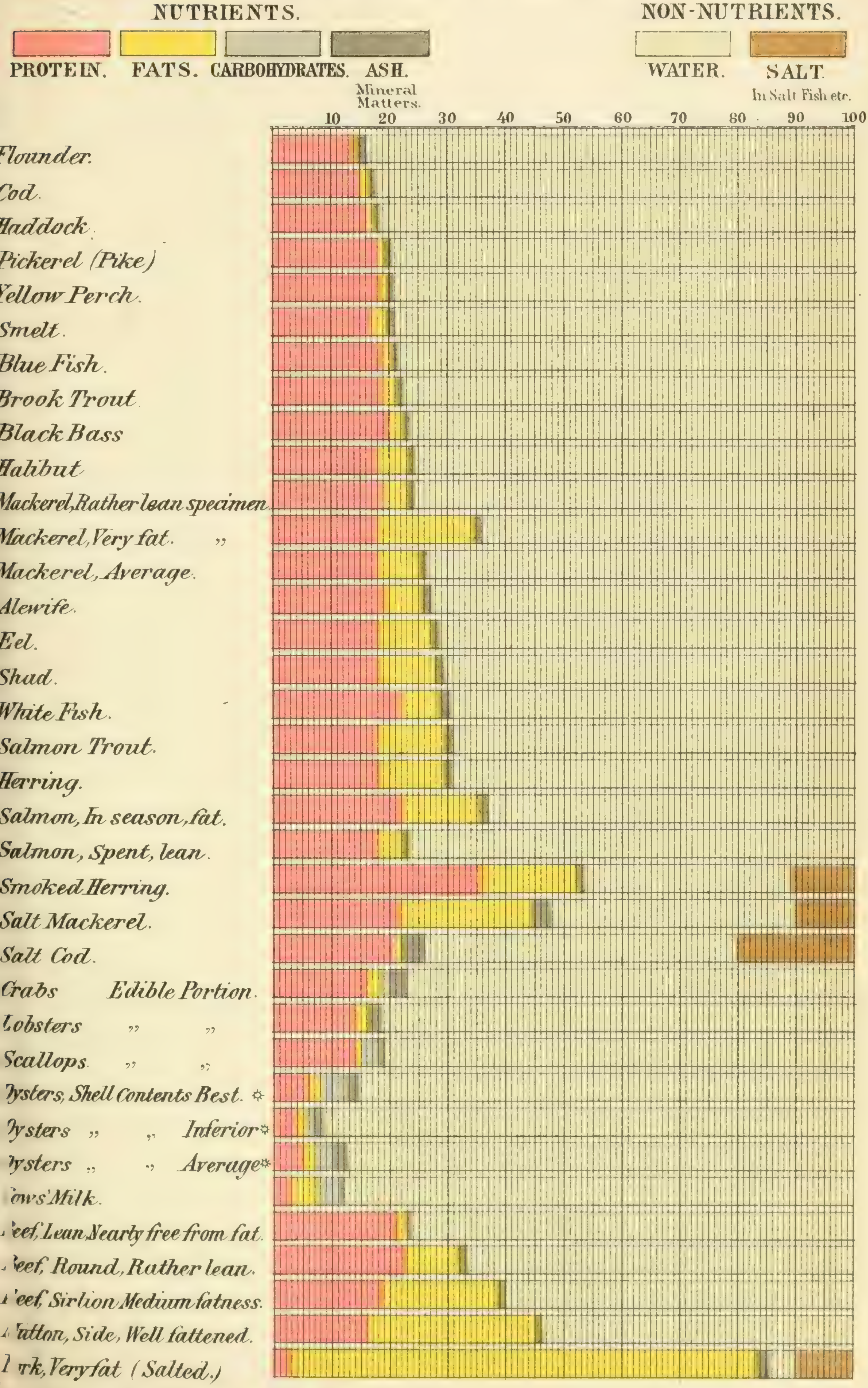
* Of forty-nine analyses.
† From flour of about average composition.
The analyses of foods in Roman letters are American, those of foods and beverages in *italics* are European.

NUTRITIVE INGREDIENTS, WATER AND REFUSE IN SPECIMENS OF FISH AND OTHER FOOD MATERIALS AS FOUND IN THE MARKETS.

Percentages Indicated by Colored Spaces.



NUTRITIVE INGREDIENTS AND WATER, ETC.
IN FLESH, EDIBLE PORTION,
(Freed from Bone, Shells and other Refuse Matters)
OF FISH AND OTHER ANIMAL FOODS.
Percentages Indicated by Colored Spaces.



* respect to quantity of nutrients without regard to flavor.

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APPENDIX D.

NATURAL HISTORY

AND

BIOLOGICAL RESEARCH.

XVI.—RESULTS OF THE EXPLORATIONS MADE BY THE STEAMER "ALBATROSS," OFF THE NORTHERN COAST OF THE UNITED STATES, IN 1883.

By A. E. VERRILL.

During the summer of 1883, the new United States Fish Commission steamer "Albatross," Lieut. Z. L. Tanner, commander, continued the work of dredging in the region of the Gulf Stream, along our coast, from off Cape Hatteras to Nova Scotia.* She is, in construction, well adapted to do deep-sea work, and fully equipped with improved apparatus, and therefore was able to carry the dredgings much farther out to sea than the "Fish Hawk" had been able to in previous years. The stations most distant from the coast were more than a third of the way to the Bermudas. The greatest depth successfully dredged was in 2,949 fathoms, at station 2099, N. latitude 37° 12′ 20″, W. longitude 69° 39′, August 2. Besides this, there were four successful hauls in 2,033 to 2,369 fathoms, and twenty-seven between 1,000 and 2,000 fathoms. Between 500 and 1,000 fathoms there were nineteen hauls, and in less than 500 fathoms, sixty-three, making a total of one hundred and sixteen stations. At nearly all the localities, except on the rocky bottoms off Nova Scotia, a large beam-trawl was used, and in most cases large quantities of specimens were obtained, even at great depths. The bottom temperatures between 1,000 and 2,000 fathoms were usually between 37° F. and 39° F., and rarely 40°.

The minimum temperatures at the bottom, in this region, are between

* It is but just to say that the unusual thoroughness and remakable success of these explorations of the Gulf Stream region have been due to the great skill and untiring zeal and energy of Captain Tanner, who has personally superintended all our deep-sea dredging operations during the past five years. It is proper to add that his efforts have been well supported by the other officers associated with him.

The naturalists associated with the writer in this work in 1883 were: Prof. S. I. Smith, Mr. Sanderson Smith, Prof. L. A. Lee, Mr. Richard Rathbun, Mr. J. H. Emerton (also as artist), Mr. B. F. Koons, Prof. Edwin Linton, Mr. H. L. Bruner, Mr. J. E. Benedict (naturalist attached to the steamer), Mr. R. S. Tarr, W. E. Safford, ensign U. S. N., and others, more or less. Mr. Peter Parker, Mr. John A. Ryder, Dr. Theodore Gill, and R. H. Miner, ensign U. S. N., worked on the fishes. The parties who went out dredging on the the steamer varied from time to time. Usually only three or four naturalists, besides Mr. Benedict, could be properly accommodated on board. I took no part in this portion of the work, in 1883, not going out on the steamer at all.

36° and 37° F., even below 2,000 fathoms. But temperatures, practically identical, have often been taken in about 1,000 fathoms, or even less. Therefore the minimum temperatures may be considered as practically reached at 1,000 fathoms, off our coast. Below that, there is very little change. Accordingly, many of the special deep-sea species range from 1,000 fathoms or less to below 2,000 fathoms, in this region. Serial temperatures were also taken at various localities.

CHARACTER OF THE DEEP-SEA DEPOSITS.

Some very interesting and important discoveries were made in regard to the nature of the materials composing the sea bottom under the Gulf Stream at great depths. These observations are of great interest from a geological point of view, as they illustrate the kinds of sedimentary rocks that may be formed far from land and in deep water, and some of them are contrary to the experience of other expeditions and not in accordance with the generally accepted theories of the nature of the deposits so far from land. The bottom between 600 and 2,000 fathoms, in other regions, has generally been found to consist mainly of "globigerina ooze," or, as in some parts of the West Indian seas, of a mixture of globigerina and pteropod ooze. Off our northern coasts, however, although there is a more or less impure globigerina ooze, in such depths, at most localities beneath the Gulf Stream, this is by no means always the case. The "globigerina ooze" usually has the consistency of fine, sticky mud, commonly of a gray, dull olive-green or bluish color. When washed through a very fine sieve a variable, but often large, proportion remains on the sieve, composed chiefly of the shells of *Globigerina* and other foraminifera, of many kinds, but mostly minute species, which live at or near the surface of the sea and fall to the bottom when dead or disabled. With these are many larger forms, both of calcareous and sand-covered species, which live at the bottom. In many places there are large quantities of the brown, sandy, rod-like and triradiate species (*Rhabdamminia*), in which the rays become about half an inch long. These are mingled with small shells, annelid tubes, fragments of echinoderms, otoliths of small fishes, &c., together with a variable proportion of true beach sand. The globigerina ooze, as found off our coast, even from below 1,000 fathoms, is always mixed with some fine siliceous and granitic sand, in which grains of quartz, feldspar, and mica can easily be distinguished under the microscope; in shallow water (100 to 400 fathoms) the sand is coarser, with the grains easily visible to the naked eye, but of the same nature, and frequently contains much clay-mud. In several instances the bottom between 500 and 1,200 fathoms has been found to consist of tough and compact clay, so thoroughly hardened that large angular masses, sometimes weighing more than 50 pounds, have been brought up in the trawl, and have not been washed away appreciably, notwithstanding the rapidity with which they have been drawn up through about two miles of water. In fact, these masses of

hard clay resemble large angular blocks of stone, but when cut with a knife they have a consistency somewhat like hard castile soap, and in sections are mottled with lighter and darker tints of dull green, olive, and bluish gray. When dried they develop cracks and break up into angular fragments. This material is genuine clay, mixed with more or less sand, showing under the microscope grains of quartz and feldspar with some scales of mica. More or less of the shells of *Globigerina* and other foraminifera are contained in the clay, but they make up a very small percentage of the material.*

LIST OF STATIONS OCCUPIED BY THE "ALBATROSS" IN 1883.

The following abbreviations are used to indicate the character of the bottom. They are the same as those used by the United States Coast Survey with a few additions desirable for greater precision:

Materials.	Colors.	Other qualities.
B. for barnacles.	bk. for black.	brk. for broken.
C. for clay.	bn. for brown.	cal. for calcareous.
Cns. for concretions.	bu. for blue.	crs. for coarse.
Cr. for corals.	db. for drab.	dia. for diatomaceous.
F. for foraminifera.	dk. for dark.	fne. for fine.
G. for gravel.	gn. for green.	fer. for ferruginous.
M. for mud.	gy. for gray.	glb. for globigerina.
O. for ooze.	lt. for light.	hrd. for hard.
P. for pebbles.	ol. for olive.	lpy. for lumpy.
R. for rocks.	rd. for red.	rky. for rocky.
S. for sand.	sl. for slate.	sft. for soft.
Sh. for shells.	wh. for white.	shy. for shelly.
Spg. for sponges.	yl. for yellow.	sml. for small.
St. for stones.		sps. for specks.
		sty. for sticky.

In the following list the character of the bottom is not always given as in the original record, for in some cases colors or other qualities have been omitted, when unimportant, for the sake of condensation. In other cases additions or alterations have been made based on the materials actually brought up in the dredge or trawl, often in large quantities:

Station.	Locality. N. lat.	Locality. W. long.	Fathoms.	Bottom.	Temp., F. Bottom.	Temp., F. Surface.	Hour.	Date.
	OFF CHESAPEAKE BAY.							
	° ′ ″	° ′ ″			°	°		
2001	37 46 30	74 00 00	499	gn. M.	......	......	....	Mar. 22
2002	37 20 42	74 17 36	641	gn. M.	......	? 48	....	Mar. 23
2003	37 16 30	74 20 36	640	....	......	? 50	....	Mar. 23
2004	37 19 45	74 26 00	98	gn. M. Sh.	......	? 51	....	Mar. 23
2005	37 18 11	74 27 36	78	M. S. Sh.	......	? 50	....	Mar. 23
2006	37 19 11	74 26 06	492	M. fne. S.	......	? 50		Mar. 23
	OFF CAPE HATTERAS.							
2007	35 17 00	75 13 00	15	fne. S.	? 68	? 56	8.00 a. m.	Apr. 27
2008	35 09 40	75 04 36	88	M. fne. S.	? 74	? 72	10.15 a. m.	Apr. 27

*This kind of material was encountered in much larger quantities during the past season (1884) than in 1883. See American Journal of Science for November, 1884.

Station.	Locality. N. lat.	Locality. W. long.	Fathoms.	Bottom.	Temp., F. Bottom.	Temp., F. Surface.	Hour.	Date.
	OFF CAPE HATTERAS—continued.							
	° ′ ″	° ′ ″			°	°		
2009	35 29 35	74 46 45	531	....	......	? 69	8.45 a. m.	Apr. 28
2010	35 30 00	74 44 45	890	....	......	? 61	10.40 a. m.	Apr. 28
2011	36 38 30	74 40 10	81	s. brk. sh.	......	? 48	9.00 a. m.	Apr. 30
2012	36 41 15	74 39 50	66	....	......	? 52	10.15 a. m.	Apr. 30
2013	36 45 30	74 25 30	888	gn. M.	......	? 48	1 05 p. m.	Apr. 30
2014	36 41 05	74 38 53	373	s. brk. sh.	......	? 47	6.35 a. m.	May 1
	OFF CHESAPEAKE BAY.							
2015	37 31 00	74 53 30	19	fne. s. sh.	......	......	8.39 a. m.	May 5
2016	37 31 00	74 52 36	19	fne. s. sh.	45	45	9.06 a. m.	May 5
2017	37 30 48	74 51 29	18	fne s. sh.	46	45	9.50 a. m.	May 5
2018	37 12 22	74 20 04	788	bu. M.	39	54	12.07 p. m.	May 7
2019	37 15 52	74 23 52	600	bu. M.	39	52	4.13 p. m.	May 7
2020	37 37 50	74 15 30	143	fne. s. M.	......	54	5.30 a. m.	May 21
2021	37 36 00	74 16 00	179	M. s.	45	54	7.00 a. m.	May 21
2022	37 32 00	74 13 20	487	M. s.	40	52	10.00 a. m.	May 21
2023	37 48 00	74 01 30	377	M. fne. s.	......	56	3.15 p. m.	May 21
	OFF MARTHA'S VINEYARD.							
2024	40 02 10	70 27 00	221	dk. gn. M.	40	49	5.51 a. m.	May 25
2025	40 02 05	70 27 00	239	M. fne. s.	40	49	7.20 a. m.	May 25
2026	40 04 00	70 28 50	131	gn. M. s.	48	49	9.00 a. m.	May 25
2027	39 58 25	70 37 00	198	bu. M. s.	43	52	12.21 p. m.	May 25
2028	39 57 50	70 32 00	204	bu. M.	41	52	2.05 p. m.	May 25
2029	39 42 00	70 47 00	1,168	gn. M.	38	53	5.13 p. m.	May 25
2030	39 29 45	71 43 00	588	bu. M.	......	49	6.20 a. m.	May 26
2031	39 29 00	72 19 55	74	M. wh. s.	49	50	1.05 p. m.	May 26
2032	39 29 00	72 19 40	73	M. s. brk. sh.	47	50	2.10 p. m.	May 26
2033	39 32 30	72 18 35	379	gn. M.	41	49	5.00 p. m.	May 26
2034	39 27 10	69 56 20	1,346	glb. O.	38	72	8.55 a. m.	July 17
2035	39 26 12	70 02 37	1,362	glb. O.	..	71	2.50 p. m.	July 17
2036	38 52 40	69 24 40	1,735	glb. O.	38	76	4.30 a. m.	July 18
2037	38 53 00	69 23 30	1,731	glb. O.	38	76	1.22 p m.	July 18
2038	38 30 30	69 08 25	2,033	glb. O.	......	76	2.32 p. m.	July 26
2039	38 19 26	68 20 20	2,369	glb. O.	......	81	noon.	July 28
2040	38 35 13	68 16 00	2,226	glb. O.	......	76	4.20 a. m.	July 29
2041	39 22 50	68 25 00	1,608	glb. O.	38	72	3.50 a. m.	July 30
2042	39 33 00	68 26 45	1,555	glb. O.	38	71	10.32 a. m.	July 30
2043	39 49 00	68 28 30	1,467	glb. O.	38	72	5.07 p. m.	July 30
2044	40 00 30	68 37 20	1,067	glb. O.	39	72	5.25 a. m.	July 31
2045	40 04 20	68 43 50	373	M. fne. s.	40	72	10.00 a. m.	July 31
2046	40 02 49	68 49 00	407	bu. M.	40	72	noon.	July 31
2047	40 02 30	68 49 40	389	bu. M.	......	72	2.15 p. m.	July 31
2048	40 02 00	68 50 30	547	s. G. M.	......	72	3.56 p. m.	July 31
2049	39 43 40	69 20 00	1,025	bu. glb. M.	39	71	3.35 a. m.	Aug. 1
2050	39 43 50	69 21 20	1,050	glb. O.	......	72	9.15 a. m.	Aug. 1
2051	39 41 00	69 20 20	1,106	glb. O.	39	72	2.34 p. m.	Aug. 1
2052	39 40 05	69 21 25	1,098	glb. O.	......	73	6.16 p. m.	Aug. 1
	OFF GEORGE'S BANK.							
2053	42 02 00	68 27 00	105	bu. M.	......	61	5.00 a. m.	Aug. 29
2054	42 03 30	68 26 00	105	bu. M.	......	64	6.20 a. m.	Aug. 29
2055	42 32 00	68 17 00	99	M. crs. G.	......	60	9.24 a. m.	Aug. 30
2056	42 01 30	68 01 00	97	fne. s. G.	......	57	3.23 p. m.	Aug. 30
2057	42 01 00	68 00 30	86	s. B. brk. sh.	......	57	4.26 p. m.	Aug. 30
2058	41 57 30	67 58 00	35	gy. s.	50	58	6.39 p. m.	Aug. 30
2059	42 05 00	66 46 15	41	bu. M. s.	......	55	5.00 a. m.	Aug. 31
2060	42 10 00	66 46 15	123	s. B. brk. sh.	......	55	7.10 a. m.	Aug. 31
2061	42 10 00	66 47 45	115	bu. M. s.	40	54	8.00 a. m.	Aug. 31
2062	42 17 00	66 37 15	150	s. G. B.	42	61	10.47 a. m.	Aug. 31
2063	42 23 00	66 23 00	141	s. crs. G. B.	46	57	1.26 p. m.	Aug. 31
2064	42 25 40	66 08 35	122	crs. s. G. B.	......	56	4.32 p. m.	Aug. 31
	OFF CAPE SABLE.							
2065	42 27 00	65 00 45	80	s. G. B.	44	55	7.00 p. m.	Aug. 31
2066	42 19 40	65 49 30	65	st. G. B.	43	54	5.00 a. m.	Sept. 1
2067	42 15 25	65 48 40	122	s. G. B.	46	56	7.05 a. m.	Sept. 1
2068	42 03 00	65 48 40	131	s. fne. G.	42	56	10.30 a. m.	Sept. 1
2069	41 54 50	65 48 35	101	s. st. G. cr.	42	56	1.34 p. m.	Sept. 1
2070	41 55 30	65 47 10	113	P. coral	42	57	2.58 p. m.	Sept. 1
2071	41 56 20	65 48 40	113	P. coral	......	57	4.10 p. m.	Sept. 1

Station.	Locality. N. lat.	W. long.	Fathoms.	Bottom.	Temp., F. Bottom.	Surface.	Hour.	Date.
	OFF CAPE SABLE—continued.							
	° ′ ″	° ′ ″			°	°		
2072	41 53 00	65 35 00	858	gy. M.	39	56	6.15 a. m.	Sept. 2
2073	41 54 15	65 39 00	586	gy. S.	40	58	10.41 a. m.	Sept. 2
2074	41 43 00	65 21 50	1,309	fne. glb. M.	40	69	6.42 a. m.	Sept. 3
2075	41 40 30	65 35 00	855	fne. glb. M.	39	58	3.41 p. m.	Sept. 3
2076	41 13 00	66 00 50	906	bu. glb. M.	......	69	3.20 a. m.	Sept. 4
2077	41 09 40	66 02 00	1,255	bu. glb. M.	39	68	8.00 a. m.	Sept. 4
2078	41 12 50	66 12 20	499	gy. M. S.	40	66	1.40 p. m.	Sept. 4
2079	41 13 00	66 19 50	75	wh. S.	45	67	4.15 p. m.	Sept. 4
2080	41 13 00	66 21 50	55	gy. S.	46	67	5.10 p. m.	Sept. 4
2081	41 10 20	66 30 20	50	wh. S. P. B.	46	56	6.50 p. m.	Sept. 4
2082	41 09 50	66 31 50	49	crs. S. B.	46	55	7.40 p. m.	Sept. 4
2083	40 26 40	67 05 15	959	gy. M.	40	72	4.30 a. m.	Sept. 5
2084	40 16 50	67 05 15	1,290	bu. M. S.	40	78	9.09 a. m.	Sept. 5
	OFF MARTHA'S VINEYARD.							
2085	40 05 00	70 34 45	70	bu. M.	50	68	6.56 a. m.	Sept. 20
2086	40 05 05	70 35 00	69	M. S.	52	67	9.20 a. m.	Sept. 20
3087	40 06 50	70 34 15	65	M. wh. S.	50	67	10.30 a. m.	Sept. 20
2088	39 59 15	70 36 30	143	yl. S.	48	68	12.40 p. m.	Sept. 20
2089	39 58 50	70 39 40	168	gy. S.	45	69	3.13 p. m.	Sept. 20
2090	39 59 40	70 41 10	140	S. brk. sh.	48	68	4.40 p. m.	Sept. 20
2091	40 01 50	70 59 00	117	gn. M.	49	69	5.30 a. m.	Sept. 21
2092	39 58 35	71 00 30	197	gn. M.	45	67	7.50 a. m.	Sept. 21
2093	39 42 50	71 01 20	1,000	F. S. M.	39	69	1.12 p. m.	Sept. 21
2094	39 44 30	71 04 00	1,022	F. S. M.	38	68	5.07 p. m.	Sept. 21
2095	39 29 00	70 58 40	1,342	glb. O.	......	69	9.02 a. m.	Sept. 30
2096	39 22 20	70 52 20	1,451	glb. O.	37	69	2.07 p. m.	Sept. 30
	OFF CHESAPEAKE BAY.							
2097	37 56 20	70 57 30	1,917	glb. O.	......	72	5.30 a. m.	Oct. 1
2098	37 40 30	70 37 30	2,221	glb. O.	......	72	1.08 p. m.	Oct. 1
2099	37 12 20	69 39 00	2,949	glb. O.	......	82	5.30 a. m.	Oct. 2
2100	39 22 00	68 34 30	1,628	glb. O.	37	69	11.05 a. m.	Oct. 3
2101	39 18 30	68 24 00	1,686	glb. O.	37	67	4.31 p. m.	Oct. 3
	OFF DELAWARE BAY.							
2102	38 44 00	72 38 00	1,209	glb. O.	39	62	....	Nov. 5
2103	38 47 20	72 37 00	1,091	glb. O.	39	62	....	Nov. 5
2104	38 48 00	72 40 30	991	bu. glb. M.	41	63	....	Nov. 5
	OFF CHESAPEAKE BAY.							
2105	37 50 00	73 03 50	1,395	glb. O.	41	63	....	Nov. 6
2106	37 41 20	73 03 20	1,497	glb. O.	42	63	....	Nov. 6
	OFF CAPE HATTERAS.							
2107	35 19 30	75 15 20	16	fne. S. sh.	......	76	....	Nov. 9
2108	35 16 00	75 02 30	48	M. crs. S.	66	78	....	Nov. 9
2109	35 14 20	74 59 10	142	bu. M.	50	76	....	Nov. 9
2110	35 12 10	74 57 15	516	bu. M.	40	75	....	Nov. 9
2111	35 09 50	74 57 40	938	gn. M.	......	76	....	Nov. 9
2112	35 20 50	75 18 00	15	S. bk. sp.	73	70	....	Nov. 10
2113	35 20 30	75 19 00	15	S. M.	72	70	....	Nov. 10
2114	35 20 00	75 20 00	14	S. M.	72	70	....	Nov. 10
2115	35 49 30	74 34 45	843	M. fne. S.	39	78	....	Nov. 11
2116	35 45 23	74 31 25	888	M. fne. S.	39	77	....	Nov. 11

In many instances we have also dredged pebbles and small, rounded bowlders of granite and other crystalline rocks from beneath the Gulf Stream in deep water. These, I suppose, have been carried to that region by shore-ice floating off in great quantities from our northern coasts in winter and spring, and melting where the warm Gulf Stream water is encountered. The coarser sands and gravel are probably carried there in the same way, but the fine sand, in part at least, probably

floats out to this region after drying on the beaches during ebb tide, by reason of the adherent air and repellant action toward the water. The clay mud, with much of the fine sand, is probably carried out from the shallower water as suspended sediment. But some of the clay may result from the local decomposition of feldspathic rocks and sand at the bottom of the sea.

FAUNA OF THE DEEP WATER.

The deepest localities were all rich in animal life of many kinds.* A considerable number of interesting fishes were obtained, many of them new to our fauna. Some of these are new genera and species of great interest.

Very interesting additions to our collections were made in nearly every class of marine invertebrates, including many undescribed species and genera, some of which are of great morphological importance, while many of the described species were previously known only from distant regions on the European side of the Atlantic, in the Arctic or Antarctic regions, off the coast of South America, in the West Indies, or even in the Indian or Pacific Oceans. Thus our knowledge of the distribution of the deep-sea forms, both geographically and in depth, has been greatly increased. Some of these deep-sea species were first described as fossils from the European tertiaries. Moreover, a considerable number of our shallow-water species have been found to have a much greater range in depth than was anticipated, many of them going down below 500 fathoms, while some even go below 1,000 fathoms.

On the first trip of the "Albatross" from Wood's Holl, which was made July 16 to 19, four successful hauls were made with a large trawl, in 1,346 to 1,735 fathoms, on the 17th and 18th of July, two each day, besides the soundings and temperature determinations, including series of temperatures at various distances from the surface. On this trip about one hundred and five species of Invertebrates were obtained, not including the Foraminifera and other minute forms. There were among them fourteen species of Anthozoa; two of Hydroids; twenty-two of Echinoderms; thirty-eight of Mollusca; fifteen of Crustacea; one of Pycnogonida; ten of Annelida; one of Bryozoa; two of Sponges.

ANTHOZOA.

The Anthozoa were abundant, both in individuals and species, in most of the dredgings. From below 1,000 fathoms there were numer-

*An account of the Crustacea was published in the July number of the American Journal of Science by Prof. S. I. Smith, who has also published a detailed account of that group, with figures, in the Fish Commission Annual Report, part x. The writer has published a detailed paper on the Mollusca, with five plates, in the Trans. Conn. Acad., vol. vi, and also a brief general account of the work of the season in the American Journal of Science, vol. 28, p. 213, with descriptions of new species of Echinoderms and Anthozoa. Some of the new fishes have been described by Messrs. Gill and Ryder.

ous species, many of them of great interest. About forty species were taken, altogether, belonging to all the principal groups. Several were undescribed, while others are new additions to our fauna, though previously obtained elsewhere by the "Blake" or "Challenger." It was also a source of satisfaction to us that we rediscovered, in larger numbers, the few remaining species that the "Blake" and "Challenger" had discovered off our coast, but which the Fish Commission had not previously dredged.

The Pennatulacea were among those of greatest interest, and of these several fine species occurred, among which were two large and handsome species of the rare and curious genus *Umbellula*. In this genus there is at the summit of the tall, slender stem a close cluster of large, flower-like, deep red, orange-red, or purplish-red polyps, each with eight long, pinnate tentacles. The flexible stem is often 2 feet or more in length, and terminates at the base in a long, hollow, muscular bulb, which serves as an anchor when inserted into the mud. The first known species of this genus was brought up on a sounding line from deep water, off the coast of Greenland, early in the last century, and one of the two specimens was described by Ellis, and the other by Mylius with rude but characteristic figures. These specimens seem to have been lost. From that time it remained unknown until within a few years, and was often a source of doubt and perplexity to the systematists. The modern deep-sea explorations, and especially those of the "Challenger," have brought to light several additional species, and proved that the genus inhabits all the oceans in deep water. But no specimens of the genus had been taken on the North American coast before last year, though a small one had been dredged in the West Indies by the "Blake." One of our species appears to be *U. Guntheri* Kölliker (fig. 3), first dredged on the other side of the Atlantic by the "Challenger;" the second and more common was apparently new (*U. Bairdii* V., fig. 2). It differs from the former in having longer and perfectly smooth polyps, with lanceolate clusters of zoöids running up between them. It is 2 feet high, with the polyp-bodies over an inch in length. Both occurred in 1,731 to 2,033 fathoms, and sometimes together. The handsome, small, dark red *Pennatula aculeata* (fig. 7) has been taken many times, both by the "Albatross" and "Fish Hawk," and often in great numbers, as many as 100 to 200, and in one case 494 specimens in a single haul. Like most of the Pennatulacea it is brilliantly phosphorescent. It ranges from 100 to 1,255 fathoms, but is most abundant between 150 and 300 fathoms. A much larger and finer species (*P. borealis*, fig. 8), usually considered rare, but frequently brought in by our halibut fishermen from the northern banks, was dredged several times in 192 to 1,255 fathoms. It grows to the height of 18 inches or more, and is often 4 or 5 inches broad across the pinnæ. Its color is usually bright orange-red, varying to brownish red and to light orange. A large, handsome and very remarkable new species for which it is necessary to constitute a

new genus, if not also a new family, was taken once, in 1883, in 843 fathoms, but two better specimens were taken, in 1884, in 991 and 1,073 fathoms. This I have named *Benthoptilum sertum* (fig. 4). It has the general form of a large *Pennatula*, with short, thick, fleshy, oblique pinnæ, from which spring several rows of numerous large and very long, soft, fleshy polyps, without calicles and without spicula, each group forming a boquet-like cluster of flower-like polyps, which in life are blood-red.

The singular club-shaped genus, *Kophobelemnon*, was represented by two species. One of these, which was undescribed (*K. tenue* V., fig. 5), is long, slender, and smooth, with a number of large polyps. It was taken in 499 to 2,369 fathoms, and in considerable numbers in some localities. The other and smaller rough species (*K. scabrum* V.) was previously known from a single specimen taken by the "Blake" in 1880. It occurred in 788 fathoms, but was taken more abundantly in 1884. A handsome new species, from 6 inches to a foot high, and slender, with many spiculose flower-like polyps in a row along each side on the upper half, was dredged in many localities by the "Albatross" in 1,467 to 2,369 fathoms. It belongs to the genus *Scleroptilum* (*S. elegans* V., fig. 6). This genus was previously known only from a related species taken off Japan by the "Challenger." Many of our specimens had a new species of Ophiuran (*Hemieuryale tenuispina* V., fig. 55) clinging closely to them, with its long, slender arms, which are provided with rough-tipped spines, closely coiled around the coral, which, like its commensal, is bright orange in color.

This Ophiuran is similar in habits to the *Astrophytons*, but, unlike most of the latter, the arms do not branch. All of this family habitually live clinging to Alcyonaria of various kinds, and generally agree in a most remarkable manner in color, and frequently, also, in the rough ornamentation of the surface, with the branches of the gorgonians to which they cling. This indicates a protective adaptation, both of color, form, and ornamentation, running through a large group, and inhabiting all the oceans, both in shallow and deep water. Two simple-armed species of this group, with similar habits, were also taken by us, one of which (*Astronyx Loveni*) lives clinging to several slender Pennatulacea, including *Distichoptilum gracile* V., *Anthoptilum grandiflorum* V., and *A. Murrayi* K. Another (*Astrochele Lymani* V., fig. 53) lives in large numbers on the bushy gorgonian coral, *Acanella Normani* V., with which it agrees in its orange or salmon-color. The two species of *Anthoptilum* referred to grow in long, stout, wand-like forms, with numerous large, naked, flower-like polyps in oblique rows. *A. grandiflorum* is much the larger, growing over 2 feet high and an inch in diameter, with many hundreds of polyps. It was dredged in 302 to 1,106 fathoms, but was first described by me in 1879 from many large specimens brought in by the Gloucester halibut fishermen from off Nova Scotia, on the deep-water banks. It was afterward described by Kölliker under a new name (*A. Thomsoni*) from specimens dredged by the "Chal-

lenger" off Buenos Ayres. *A. Murrayi* K. was first taken by the "Challenger" off Nova Scotia. The "Albatross" dredged it in 640 to 1,362 fathoms. Other tall, wand-like species are *Funiculina armata* V., which is very slender, and *Balticina Finmarchica*, fig. 11. The latter frequently grows to the length of a yard and is about an inch in diameter. Many of the specimens have the round, stony axis stripped bare at the end, and sometimes in other places, for a longer or shorter distance, by accidental injuries. Nearly always these naked places are occupied by a peculiar species of Actinian (*Actinauge nexilis* V., fig. 22), which starts like ordinary young Actinians, with a flat base, but the sides of the base spread out thin and wrap around the axis of the coral till they meet on opposite sides, when they coalesce by a firm suture, inclosing the coral in a sort of tube or sheath, and when several of them start near together their bases mutually coalesce where they come in contact, thus forming a continuous covering over the dead coral. This Actinian grows to a rather large size, and the weight of a cluster, often of five or six, and in one case nine, at the top of the tall, slender axis causes it to bend over, so that they are pendulous on the nodding summit of the coral. By certain writers this denuded condition of the axis of this species has been supposed to be normal, or at least constant, but I have seen numerous specimens that are perfect to the tip. Several other deep-sea Actinians from this region have the same habit of growth, inclosing the denuded axis of various species of Gorgonians. One of the most abundant of these is *Sagartia Acanellæ* V., fig. 25, which thus incloses denuded portions of the bush-coral, *Acanella Normani.* It has the same orange or salmon color as the coral on which it lives.

The Gorgonacea or "bush corals," are well represented, at great depths, by several handsome species, some of them 2 or 3 feet high, and nearly all belonging to genera that are peculiar to the deep sea, for which they are specially adapted by a peculiar modification of the base, which divides into a number of divergent, root-like branches, sometimes becoming much divided and slender, but more commonly flat and irregular. These penetrate, like roots, into the soft mud and thus give a secure anchorage on bottoms where no solid foundation could be had for species that adhere only to solid objects by a flat expansion of the base, as in nearly all shallow-water species. The root-like base is characteristic of the genera *Acanella*, *Lepidisis*, *Dasygorgia* and *Lepidogorgia* found in our region, and of many others found elsewhere in deep-sea dredging. Most of these corals are orange, orange-red, or salmon-color in life, some of them varying to red or to orange-brown. One of the most elegant of these, dredged in 1,346 to 1,362 fathoms, is *Dasygorgia Agassizii* V., first discovered by the "Blake." It is a plumose, much branched coral, with the terminal twigs very slender, while the main branches are spirally arranged. Its axis is slender, calcareous, and iridescent, and its root-like base is divided into short, flat, irregular branches. Its polyps are prominent, relatively large, rather far apart,

and obliquely seated on the branches. It belongs to the family *Chrysogorgidæ*, recently established by the writer for this and several other related deep-sea genera, nearly all having a brilliantly iridescent axis, and most of them with spiral branches.

We also dredged, in 858 to 1,735 fathoms, another allied new species, representing a new genus in this family. I have called it *Lepidogorgia gracilis.* It grows in the form of a very slender, tall, round, unbranched stem, about 3 feet high. The axis is iridescent, and the root is divided into many divergent branches, which are stony, white, round, and much branched, and when detached look like branching corals of a very different nature. The polyps are large, prominent, obliquely seated, secund and far apart along the stem, which is covered with a thin layer of small oblong scales. *Lepidisis caryophyllia* V. is also a coral that grows in the shape of a tall simple stem, a yard or more high, but its axis is divided into joints, the longer ones white, calcareous, and hollow, alternating with brown, short, horny ones. Its polyp-calicles are spinose and very long and clavate, and when the tentacles are, as usually seen, rolled up in a ball at the end, they resemble cloves in shape, a character to which the name refers. It was often taken in 1,098 to 1,735 fathoms, and its dead, stony joints must be abundant on the bottom, for they afford attachment for many other creatures of various kinds. The smaller and much branched, bush-like, orange-brown coral, *Acanella Normani* V., is the most common of all the corals. It has been dredged in a great many localities, both by the "Fish Hawk" and "Albatross," in 225 to 1,300 fathoms, often in great numbers, several hundreds sometimes coming up in a single haul. It grows about a foot high, and is often nearly as broad as high, its branches growing out three or four together, in close whorls, from the horny joints. It is decidedly phosphorescent. Many other creatures, such as Actiniæ, hydroids, barnacles, worms, and Ophiurans of several species are frequently attached to it, so that in this way it is a valuable aid to us in bringing up these abyssal creatures. One peculiar Ophiuran, *Astrochele Lymani* V., occurs in great numbers on this coral, which is its regular home. It twines its long slender arms, which bear numerous clusters of small hooks, closely around the branches of the coral, and it cannot be easily removed without breaking the arms. A dozen or more frequently occur on a single coral, and are often accompanied by *Ophiacantha millespina* and other species having similar habits.

The *Acanthogorgia armata* V. is a large and much branched gorgonian with a horny axis, and long, clavate, spinose calicles. Some fine living specimens were taken in 407 and 640 fathoms. When living it was pale orange, or salmon-color, but it quickly turns either dark brown or black in alcohol or when dried. On the outside of Brown's Bank, off Southern Nova Scotia, at several stations, the "Albatross" dredged, in 101 to 131 fathoms, a number of good specimens of the great bush-coral, *Prim-*

noa lepadifera, thus accurately fixing one of its localities. It is often brought in by the Gloucester fishermen.

Among the Alcyonacea there were a few interesting forms. One of these, *Anthomastus grandiflorus* V. (fig. 12), grows somewhat in the form of a mushroom, with a broad, rounded top and a stout stem, which may either be attached to stones by a flat base, or penetrating the mud it may branch and divide into many curious little bulb-like expansions to form an anchorage. When full grown, it becomes large and hemispherical, often 4 to 5 inches broad, with a short, broad stem, while a number of very large, flower-like polyps are scattered over the top. Smaller specimens have but few of the large polyps, which are often an inch and a half across the tentacles, but there are many minute zoöids on the surface between the polyps. Its color is dark red, or purplish red. It has been dredged in considerable numbers by the "Fish Hawk" in 410 to 458 fathoms, and by the "Albatross" in 858 to 1,395 fathoms. It was also obtained previously, of large size, by the Gloucester fishermen, from the outer banks off Nova Scotia. More recently, it has been redescribed from the Norwegian coast under the name of *Sarcophyton purpureum* Kor. & Dan.

There were also two large species allied to *Alcyonium*. One of the latter (fig. 13), common in 1,290 to 1,608 fathoms, almost always starts on a joint of *Lepidisis caryophyllia*, but its thin expanding base, after surrounding the coral, descends deeply into the mud, in a hollow, bulb-like form, firmly inclosing a ball of mud for an anchorage, a habit similar to that of several of the large Actinians.

There are several species of cup-corals living in deep water off our northern coast. Several of these are large and handsome species. The largest and most common, which we have also taken in considerable numbers every year on the "Fish Hawk," in 164 to 787 fathoms, is *Flabellum Goodei* V (fig. 14). It has a strongly compressed form, often with flat sides, and is very fragile. Large specimens are often 3 or 4 inches across the longest diameter. The animal is orange, with the lips and tentacles purplish red or brown. A second species of *Flabellum* (*F. angulatum* Moseley, fig. 15) was taken last season. It is a beautiful species, with a broad, cup-shaped calicle, somewhat hexagonal in outline. It was dredged several times this year, in 906 to 1,467 fathoms, and was originally discovered by the "Challenger," off Nova Scotia. The third species is a handsome coral (*Caryophyllia communis*, fig. 16) of which a number of fine, large, living specimens were dredged in 1,098 to 1,106 fathoms. It is narrow, cup-shaped at summit, but terminates in a rather acute base, which is turned to one side more or less decidedly. It was originally described as a fossil from the Italian tertiary formation.

Another very fragile cup-coral, interesting on account of its remarkable habit of restoring itself, after being broken, by budding out from every fragment, so that most of the specimens have a larger or smaller frag-

ment of the dead parent coral adhering to its base, is *Dasmosmilia Lymani* (fig. 17). It was taken in 57 to 1,091 fathoms.

The Actinians are represented in deep water by several very large species, some of them handsomely colored. Several hundreds often come up in a single haul of the trawl, making a bushel or more in bulk. As most of these secrete from their surfaces a large amount of slimy mucus, their presence in such numbers is often a nuisance, as the slime obscures and injures rarer and more delicate things. An orange or pale red species, *Bolocera Tuediæ*, living mostly in 150 to 640 fathoms, is among the most common and most slimy. It has a smooth body, often 3 or 4 inches in diameter, with numerous very large light orange-red tentacles, 2 or 3 inches long and about as large as a man's fingers. These tentacles cannot be retracted and are very easily detached, and then resemble peculiar worms, for they retain the power of motion for some hours. They also have powerful stinging organs, or "nettling threads," which are able to poison the human hand severely, especially between the fingers, when the skin is softened by prolonged handling of the wet specimens, so that for those persons who are sensitive to such poisons they render the handling of the contents of the dredge rather unpleasant.

A very singular, large, soft, pinkish Lernean crustacean (*Antheacheres Dübenii* Sars, fig. 167–8) lives parasitically in the stomach of this Actinian, with which it agrees in color. It is not uncommon. A large, bright orange, scaly annelid, over 2 inches long (*Polynoë aurantiaca* V.), lives as a commensal among the tentacles.

Another common red or orange Actinian, taken in 55 to 616 fathoms, but most abundant in 150 to 400 fathoms, is *Actinauge nodosa* (fig. 20), which grows quite as large as the preceding, but has very numerous and smaller, retractile, red or orange-brown tentacles; vertical rows of tubercles cover the firm body, while just below the tentacles there is a broad zone which, like the tentacles, secretes an abundance of mucus, which is highly phosphorescent, so that when irritated the upper end of the body is illuminated, looking something like a large torch in the dark. In the deep-sea mud it has a bulbous base, but in less depths it attaches itself by a flat base to stones and shells, or clasps its base around worm-tubes and branches of corals.

Another very large and much handsomer species of this genus, with the same phosphorescent character and similar habits, is *Actinauge longicornis* V. (fig. 21), which has been taken many times in 100 to 325 fathoms. It often becomes 3 or 4 inches broad across the body, and 5 or 6 high, while the long, slender, tapered, pale pink tentacles, banded with purple, may be 3 or 4 inches long, and when fully expanded they may fill a space 10 or 12 inches in diameter, or the size of an ordinary water bucket. The body is white or pink, and has a somewhat parchment-like appearance. It bears rows of small warts. A still larger and very common species, in 60 to 640 fathoms,

is *Actinostola callosa* V. (fig. 24), which often becomes 5 or 6 inches across the body, and is usually somewhat higher than broad. It has a large number of short, thick tentacles, usually deep orange in color, while the body is lighter, varying to salmon or pale flesh-color, and has a smooth leathery texture and warty surface. This and the two preceding, when living on the deep-water muddy bottoms, have the habit of firmly inclosing a large ball of mud, often 2 or 3 inches in diameter, in the base. This is done by the basal disk first spreading out and then descending into the mud, when its edges contract so as to produce a hollow bulb, often with only a small central opening below. This bulb serves as an anchorage in the mud, but it is probable that all these species, at first, when very young, adhere to bits of corals, worm-tubes, shells, or some other solid substance, by a flat base, as usual with Actinians in shallow water, and that the base gradually becomes bulbous when it grows beyond its small support, for we often find young specimens thus attached, and have observed the bulb in all stages of formation. In some cases one half the base would be flat, and adherent to a shell, while the other half would have the bulbous form, inclosing mud. Moreover, when these same species inhabit hard bottoms, covered with shells and stones, as often happens, large specimens occur broadly attached by their flat bases, so that this must be regarded as a special adaptation suited to the peculiar conditions of muddy bottoms, but not yet become a permanent character of the genera, nor even of the species, so far as we have been able to discover.

Within the hollow bulbs, mixed with the mud, or next to the base itself, we usually find a number of chitinous pelicles, which have been secreted by the basal disk and cast off from time to time. This is not confined to either of the several genera that have bulbous bases, but is common to all. It indicates that the same ball of mud, or portions of it, at least, must be retained for a long period, or perhaps through life, for it is probable that individuals thus anchored in the mud do not move about at all, but ever afterwards remain fixed. Indeed, I have good evidence that some large individuals of *A. nodosa* attached to stones and shells remain fixed in the same place for years, without any disposition to creep about, and perhaps they may lose this power, more or less, as they grow old, though they certainly have it while young, as do most shallow-water species. The formation of the basal bulb in these Actinians, and in the *Alcyonium* above mentioned, throws much light on the probable origin of the specialized muscular basal bulb of the Pennatulacea.

A remarkable new genus (*Gondul mirabilis*) has been recently described by Koren and Danielssen,* which is attached by an adherent base, as in *Alcyonium*, but has the polyps arranged on bilateral oblique ridges, as in many Pennatulacea, and with four axial tubes,

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* Bergen's Museum, Nye Alcyonider, Gorgonider og Pennatulider til Norges Fauna, p. 19, pl. 10, 1883.

much as in the latter, while the spicula also resembles those of this group. This may represent a primitive type from which the Pennatulacea have been derived. It is only necessary to suppose that the attached base of such a form may have become bulbous and more specialized, on account of the exigencies of muddy bottoms, as in the case of our Alcyonium and Actinians, when it would become a true member of the Pennatulacea. It might, of course, be urged that it is a degraded form, derived from the Pennatulacea, but this is not probable. At any rate, it is evident that the Pennatulacea, as a group, are adapted specially for life on the soft muddy bottoms of the deep sea, and probably were originally developed there from simpler attached forms of shallow-water origin.

The bulbous bases of the large Actinians are often useful to us in dredging, because they may inclose various small shells, &c., with the mud, and some of our new discoveries have been obtained only from this source. They are also very useful to us as bringing up the most perfect samples of the mud of the bottom, with precisely the same composition that it had when undisturbed, for the bulb is often so nearly closed that none of the mud can wash out, while the contents of the dredge and trawl and of the sounding cup are more or less washed on the way up, and the finer parts may be largely lost.

Another very large and handsome species of Actinian, first discovered in 1880, but one which does not descend to great depths, inhabiting only the warm zone, in 60 to 115 fathoms, is *Urticina perdix* V. (fig. 19). When in full expansion, it is often over a foot across, with its very numerous long, slender, translucent tentacles spread out in every direction. The body is smooth and curiously mottled with shades of lighter and darker brownish, yellow, and pale flesh-color, something like the feathers of a partridge, to which the name alludes. It is one of the few deep-water species that thrives well in confinement. We have kept large individuals in aquaria all summer, without special care. It is very active, constantly changing in form, and very voracious. The temperature of the water in which it naturally lives is similar to that of the harbor at Wood's Holl in summer, while most of the other species, coming from greater depths, live in and require much colder water than can be provided without special means of cooling.

We often keep deep-sea species, of different groups, alive for a few hours or days by keeping them in water cooled down in the ice-box on the steamer, in cases where it is desirable to bring them ashore with their natural colors and appearance for descriptions and figures. But in most cases they never recover from the injury received by being drawn up through the warm upper stratum of Gulf Stream water, which is usually above 70 degrees, and although they sometimes remain alive for a day or two, they seldom show any activity, and usually die within a few hours. The Crustacea are nearly always quite dead when brought on deck, for, excepting the hermit-crabs, they are injured by the rough

treatment and crushing that they receive in the trawl, as well as by the heat of the upper waters. The same is true of the more delicate species in all of the groups. But the Mollusca having strong shells; some of the Echinoderms; and all the large, tough-skinned Actinians seem to be injured or killed by the heat alone. It is probable, therefore, that but few of the more delicate deep-sea animals will ever be seen alive by man, and still fewer in a healthy living condition.

HYDROIDA.

The Hydroids are few in species, and not numerous individually in the deeper dredgings. But at moderate depths, especially near George's and Brown's Banks, a considerable number of northern and mostly well known European species were obtained. Several interesting species also occurred, some of them frequently, in 100 to 300 fathoms, off the southern coast of New England. Some of these are undescribed. The most abundant is a species of *Tubularia* with coarse, yellow stems (*T. indivisa?*). A new species of *Cladocarpus* (*C. flexilis* V., fig. 29), with tall, slender, pinnate, yellowish stalks is also very common. A large and rather coarse hydroid, *Calicella plicatilis*, fig. 30, is also rather common.

ECHINODERMATA.

The Echinoderms were among the most abundant and interesting of the deep-sea animals. About one hundred species were dredged by the "Albatross," many of which are new to our coast, though previously dredged on the European side, or in the Caribbean Sea and still more distant regions. Others are undescribed forms. Among the Holothurians, besides several species of *Trochostoma* and allied forms, there were two gigantic species, belonging to a peculiar deep-sea family of which many species were brought to light by the "Challenger" expedition. These occurred in large numbers at several stations, mostly between 1,000 and 1,500 fathoms, in some cases more than a barrelful of one of them coming up in a single haul. The largest and most singular one was a new species of *Benthodytes* (*B. gigantea* V., figs. 31, *a*, *b*), a very large, massive species, flat below and convex above, sometimes 18 inches long and 5 or 6 broad, having a gelatinous, translucent appearance, but with a firm cartilaginous texture when fresh. The cartilage-like walls of the body are very thick, often an inch or more, and the visceral cavity is very small in proportion. Owing to the dense and impervious, cartilage-like tissues, this species is very difficult to preserve in alcohol,* the interior decaying before the fluid can penetrate the tissues, even when the visceral cavity is cut open. This has been dredged in 924 to 2,033 fathoms.

* During the season of 1884 this and other large gelatinous species (Cephalapods, &c.) were preserved in much better condition by the use of ice-cold alcohol, kept in tanks in the ice-room ready for immediate use.

From its peculiar appearance the sailors on the "Albatross" called this species "boxing gloves."

The second was also a new form, *Euphronides cornuta* V. (figs. 32–33*a*), related to *E. depressa* of the "Challenger" expedition. It has a large, conical, median posterior elevation, double at the summit, and two pairs of large, elevated, teat-like anterior tubercles. To the latter character the name refers. In form it is not unlike *B. gigantea*, but it is smaller, narrower, less massive, and has a much thinner, reddish brown, or purplish brown, spiculose integument, without the cartilaginous character of the latter. To this the sailors gave the name of "overshoes," which it somewhat resembles in form and color. It has been taken in 855 to 1,735 fathoms.

A large, brown, undescribed species of *Synapta* (*S. brychia* V.), with large anchors, was discovered in 938 fathoms. This genus has generally been considered as entirely confined to shallow water.

Of Echini, we obtained two of the curious species having flexible shells (*Phormosoma placenta* and *P. uranus*). The former was taken in many localities and in considerable numbers. *P. uranus* has often occurred in 568 to 1,080 fathoms. Some of the specimens are 8 to 9 inches in diameter, and of a rich purplish color, an unusual color for deep-sea animals. *P. placenta* ranged from 458 to 1,230 fathoms. Other interesting species, not previously dredged by us, and characteristic of the greater depths, were *Pourtalesia Jeffreysii*, in 843 to 1,555 fathoms; *Aërope rostrata*, in 1,395 to 1,608 fathoms; *Aceste bellidifera*, in 1,395 to 1,467 fathoms; *Urechinus Naresianus*, in 1,309 fathoms; *Salenia varispina*, in 547 fathoms.

The *Echinus Norvegicus* was taken in large numbers in 1,043 to 1,255 fathoms, while *Brissopsis lyrifera* and *Schizaster fragilis* were very frequently dredged this season, the former in 938 to 1,555 fathoms, the latter in 100 to 239 fathoms.

The star-fishes were very numerous in the deep dredgings and are represented by many interesting species. One of the most abundant star-fishes was a fine, new, orange-red species of *Zoroaster*, of large size, with slender spinose arms (*Z. Diomedeæ* V.). About two hundred specimens of this occurred at station 2035. It was taken at many stations, in 1,000 to 1,600 fathoms. The most common genus, as usual in very deep water, was *Archaster*, of which numerous species occurred. Many of these are very large and handsome forms, and are generally buff, salmon, orange, or orange-red in color. Several are unlike those species from less than 500 fathoms, taken by the "Fish Hawk." A large, new, orange-colored *Archaster*, with a very large madreporic plate (*A. grandis* V.) occurred in great numbers at several stations, in very deep water, often associated with *Zoroaster Diomedeæ* and *Benthopecten spinosus*. It has a small or moderate-sized, flat disk, closely covered with fine paxillæ, with long, rather flat, tapering arms, having two rows of small marginal spines on each side. In several instances I have taken from the

stomach of this star-fish specimens of sea-urchins (*Brissopsis lyrifera* and *Aceste bellidifera*) 1 to 2 inches in diameter, but partially crushed.*

A smaller and very distinct new species of this genus (*Archaster sepitus* V.), from 368 to 858 fathoms, has two regular, divergent rows of marginal spines all around, while the rather swollen marginal plates are covered with small, sharp spinules, and similar spinules cover the lower side. The adambulacral plates project strongly into the grooves and bear very convex groups of slender, tapering spines. The disk is rather small and the tapering arms moderately elongated.

A large and handsome new *Archaster* (*A. robustus* V.), remarkable for its long, high, squarish arms and smoothish appearance, was taken at several localities, in 938 to 1,467 fathoms. Its marginal plates are closely covered with small scale-like spinules, but bear no marginal spines. The disk is small and the arms long. It is sometimes over a foot in diameter. Another new and very elegant species of this genus (*A. formosus* V.) was taken sparingly at several stations, in 1,467 to 1,608 fathoms. This species has a rather broad, flat, pentagonal disk, with large, distinct, hexagonal paxillæ, while the arms rapidly narrow and have only one or two rows of paxillæ distally. Their tips are slender and terminate in a thickened apical plate. There are no marginal spines.

A very interesting new form, taken in many localities, is related to *Archaster* and *Astropecten*, closely resembling some of the spinose species of these genera in general appearance. It represented a new genus (*Benthopecten spinosus* V.). The flat dorsal surface is closely covered with tesselated, angular plates, having single, definite, small pores for solitary branchial papulæ between them, while there are no true paxillæ, the small spinules arising singly, or two or three together, directly from the plates. The marginal plates, above and below, bear single large, sharp spines, the five largest ones occupying the central interbrachial plates, on the upper margin. The disk is of moderate or rather small size, but the arms are long and tapered. It occurred in 855 to 1,917 fathoms, in 1883, but is most abundant in 1,200 to 1,500 fathoms.

Among the most interesting of all the star-fishes were two species of the remarkable genus *Brisinga*. One of these (*B. elegans* V.), taken in many localities in 1883 and 1884, in 906 to 2,021 fathoms, sometimes in large numbers, has often been obtained and preserved nearly entire. It is a handsome species with very long, slender, finely-tapered arms, usually eleven or twelve in number, but varying from nine to thirteen.

* In one case I also found in its stomach a fresh specimen of the common surface barnacle (*Lepas anatifer*), which is often found in large numbers attached to floating timber, &c., in the Gulf Stream. This *Lepas* unquestionably sank to the bottom and was swallowed by the star-fish (living at the depth of 1,395 fathoms) before decomposition had begun. This illustrates well the dependence of the deep-sea life on the surface fauna.

The small disk and the basal, slightly swollen portion of the arms are covered with small sharp spinules, arranged in small clusters or standing singly, but not forming definite transverse groups on the basal part of the arms. The marginal spines are long and very slender, and mostly stand in a single row. The other (*B. costata* V.) is a coarser species, which usually comes up broken into numerous fragments, by spontaneous division. In this species the spinules and pedicellariæ form large and prominent transverse ridges or ribs on the swollen basal part of the arms, as well as on the distal portion. It resembles the *B. coronata* Sars, in general appearance. It was taken during the last two seasons in 991 to 2,021 fathoms.

The curious little pentagonal star-fish, described by Wyville Thomson (Voyage of the "Challenger," p. 378, Figs. 97, 98), as *Porcellanaster cœruleus* (figs. 40, 41), was taken in considerable numbers at many localities, in 1883 and 1884, in 816 to 1,917 fathoms. Its cœrulean color is due only to the bluish mud, with which its large stomach is usually filled, showing through the translucent integument. The real color is buff or pale salmon.

Among the large and showy forms of star-fishes is a new species of *Solaster* (*S. abyssicola* V.), which is bright red or orange in color, and often becomes over a foot in diameter. It has a broad disk and usually eight or nine arms. It has rather small rounded clusters of spinules on moderately elevated paxillæ, both above and beneath. The spinulation is coarser and the paxillæ larger, more elevated, and less crowded than in *S. endeca*, of the shallow waters.

The Ophiurans were abundantly represented by many species, some of which were previously undescribed and others unknown from this region. Several of them are of large size and conspicuous. Among these one of the largest and most abundant was *Ophiomusium Lymani*, of which many hundreds or even thousands were often taken in a single haul in 900 to 1,100 fathoms. It has occurred at many localities in 238 to 2,033 fathoms. Another almost equally large species of the same genus (*O. armigerum* Lym.) also occurred abundantly at several stations in 1,731 to 2,369 fathoms. A handsome species, remarkable for its large and distinct, symmetrically arranged dorsal scales (*Ophioglypha bullata*), has been taken in considerable numbers in 1,608 to 2,574 fathoms. A smaller flattened species (*O. lepida* Lym.) occurred in vast numbers at several stations, both in 1883 and 1884. It seems to be very abundant at about 1,500 fathoms, and is widely diffused in 428 to 2,574 fathoms. Our perfect specimens generally, if not always, have small, slender spinules scattered over the disk, which was not the case with the original types described by Lyman. The spinules are easily rubbed off. A large species of *Ophiochiton* (*O. grandis* V.) was taken in 888 fathoms. This genus had not been taken before in this part of the Atlantic. Numerous species of *Ophiacantha*, which is a very common and characteristic deep-water genus, were taken, among which were several that

were undescribed and others not before known from this region. The species of simple-armed *Astrophytonidæ*, taken by the "Albatross," have been referred to on previous pages [pp. 8, 10]. They are often found clinging to the Pennatulacea and Gorgonians, in large numbers, in company with the various species of *Ophiacantha*.

The very common species, *Antedon dentata*, was the only crinoid obtained, with the exception of fragments and young of *Rhizocrinus* (fig. 57). Of the former we also took a few young specimens, in the attached or stemmed condition (fig. 58).

A fine species of stalked crinoid belonging to the genus, *Benthocrinus*, was dredged in 1884, in 2,021 fathoms, off Chesapeake Bay.

CRUSTACEA.

The Crustacea were very numerous and included many new forms of great interest. According to the report of Prof. S. I. Smith* there were fifty-seven species of deep-water Decapod Crustacea, besides fifteen shallow-water ones. Of these he has described nineteen as new. At the single haul in 2,949 fathoms six species were taken, while thirteen occurred below 2,000 fathoms, and twenty-nine below 1,000 fathoms.

The twenty-nine species taken below 1,000 fathoms include twenty-one Caridea, or true shrimp, two Eryontidæ, three Galatheidæ, one Paguroid, one Lithodes, and one Brachyuran belonging to the Dorippidæ.

"It is interesting to compare these results with the lists of the fauna of the North Atlantic below 1,000 fathoms, given by the Rev. Dr. Norman in the presidential address to the Tyneside Naturalists' Field Club, published last year. In Dr. Norman's lists only twelve species of Decapoda are recorded, none of them from as great a depth as 2,000 fathoms, and of these twelve species seven were known only from the 'Blake' dredgings of 1880."

In the course of subsequent studies Professor Smith has added a few more species to the list.

The deep-sea crustacea are neither degraded in structure nor small in size. Among them are representatives of all the higher groups, while many of the species are remarkable for their great size. A true crab (*Geryon quinquedens* Smith, fig. 156), common in 105 to 816 fathoms, is one of the largest crabs known, for the massive body is often 5 inches long and 6 broad. It is dark red in color. The great spiny spider-crab (*Lithodes Agassizii* Smith, fig. 151), first described from the "Blake" collection, but also taken in 1882 and 1883 by the Fish Commission, measures over 3 feet across the outspread legs, while the body is 7 inches long and 6 broad, and covered with long, sharp spines. It ranges from 410 to 1,255 fathoms. Several of the shrimp are nearly a foot long, not including the antennæ, which, like the legs, are often remarkable for their great length and slenderness.

* Report of the United States Commissioner of Fish and Fisheries, Part X, for 1882 (published 1884), p. 345, and American Journal of Science, vol. 28, p. 53, July, 1884.

The following, according to Professor Smith, are some of the more interesting forms: "A new genus of Brachyura, allied to *Ethusa*, 1,496 to 1,735 fathoms; an Anomuran belonging to A Milne-Edwards' new genus *Galacantha* [=*Munidopsis* Whiteaves], 1,479 fathoms; two species of *Pentacheles* (fig. 152, a genus of Eryontidæ allied to *Willemœsia*), between 843 and 1,917 fathoms; a stout Palæmonid (*Notostomus*, fig. 160), 6 inches long and intense dark crimson in color, 1,309 to 1,555 fathoms; a gigantic *Pasiphaë* (fig. 158), 8½ inches long, 1,342 fathoms; three species of a remarkable new genus allied to *Pasiphaë*, and also to *Hymenodora*, and some other genera of Palæmonidæ, which shows that *Pasiphaë* is closely allied to the Palæmonidæ; a large Penæid, a foot in length, referred to the little-known genus *Aristeus* (fig. 159); and a large *Sergestes*, 3 inches in length."

"A striking characteristic of the deep-sea crustacea is their red or reddish color. A few species are apparently nearly colorless, but the great majority are some shade of red or orange, and I have seen no evidence of any other bright color. A few species from between 100 and 300 fathoms are conspicuously marked with scarlet or vermilion, but such bright markings were not noticed in any species from below 1,000 fathoms. Below this depth orange-red of varying intensity is apparently the most common color, although in several species, very notably in the *Notostomus* already referred to, the color was an exceedingly intense dark crimson."

I have in former articles repeatedly called attention to the prevalence of salmon, orange, and scarlet colors among the deep-sea animals of various groups, and have insisted that these are protective colors in consequence of the peculiar nature of the light transmitted to them through a vast thickness of sea-water. This view necessarily implies that a certain amount of sunlight is thus transmitted. The existence of well developed eyes in the deep-sea fishes, cephalapods, crustacea, &c., may well be regarded as positive evidence of the existence of a certain amount of light even at the greatest depths explored. According to Prof. S. I. Smith there were sixteen species of decapod and schizopod crustacea taken by the "Albatross" at depths below 2,000 fathoms, eight of them ranging downward to 2,949 fathoms, and all these species had normal faceted eyes. Nine of then had dark-colored eyes, similar to allied shallow-water species, and not much smaller; four had small black or dark eyes; one had light-colored eyes larger that usual in the shallow-water species of the same genus; and nine had small light-colored eyes.

Professor Smith has also called attention to the remarkably large size and small number of the eggs of many of these deep-sea crustacea, their eggs being often ten, fifteen, and sometimes even more than three hundred times larger than those of allied shallow-water species.

"The large size of the eggs is a marked feature in many of the deep-water Decapoda. The eggs of *Eupagurus politus* from 50 to 500 fathoms, are more than eight times the volume of those of the closely allied and

larger *E. bernhardus* from shallow water, and in *Sabinea princeps*, from 400 to 900 fathoms, they are more than fifteen times as large as in *S. septemcarinata*, from 25 to 150 fathoms. The most remarkable cases are among the deep-water genera: *Galacantha rostrata* and *G. Bairdii*, from between 1,000 and 1,500 fathoms, have eggs 3mm in diameter in alcholic specimens, while in the vastly larger lobster they are less than 2mm. The largest crustacean eggs known to me are those of *Parapasiphaë sulcatifrons* (fig. 162), a slender shrimp less than 3 inches long, taken between 1,000 and 3,000 fathoms. Alcholic specimens of these eggs are fully 4 by 5mm in shorter and longer diameter, fully ten times the volume of the eggs of *Pasiphaë tarda* from 100 to 200 fathoms, more than three hundred and fifty times the volume of those of a much larger shallow-water *Palæmon*, and each one more than a hundredth of the volume of the largest individual of the species. From the peculiar environment of deep-water species it seems probable that many of them pass through an abbreviated metamorphosis within the egg, like many fresh-water and terrestrial species, and these large eggs are apparently adapted to producing young of large size, in an advanced stage of development, and specially fitted to live under conditions similar to those environing the adults."

"Among the Schizopoda there are two large species of *Gnathophausia*, one over 4 inches in length, and a *Lophogaster*, all from below 2,000 fathoms. One of the most interesting Schizopods is a small *Thysanoessa* (a genus of Euphausidæ) from 398 to 1,067 fathoms, of which one female was found carrying eggs. The eggs are carried in an elongated and flattened mass beneath the cephalothorax, are apparently held together by some glutinous secretion, and are attached principally to the third pair of peræopods (antepenultimate cephalothoracic appendages)."

One of the Schizopoda of frequent occurrence is *Thysanopoda Norvegica*, taken at the surface, and also apparently from 150 to 239 fathoms, in the trawl-wings.

"The Amphipoda from deep water are comparatively few in number, and have not yet been carefully examined, but among them is one specimen of the gigantic *Eurythenes gryllus* Boeck (*Lysianassa Magellanica* Milne-Edwards), probably the largest of all known Amphipoda. This specimen, which is over 4½ inches long, and very stout in proportion, was taken in 1,917 fathoms, north latitude 37° 56′ 20″, west longitude 70° 57′ 30″. The few previously known specimens came from Cape Horn, Greenland, and Finmark, and have apparently all been taken from the stomachs of fishes. This species and its occurrence in the extreme Arctic and Antarctic seas, has been much discussed, and is the subject of a long memoir by Lilljeborg, but the apparently anomalous distribution is explained by its discovery in deep water off our middle Atlantic coast."

Other Amphipods are *Themisto bispinosa*, apparently from 373 to 1,348 fathoms, in trawl-wings; and *Epimeria loricata*, in 168 to 239 fathoms.

The Cumacea and Isopoda are each represented by several species,

but these groups have not yet been fully examined. Among the Isopods, one of the largest and most common is *Syscenus infelix* Harger (fig. 164), which is orange in color. Another singular species is *Astacilla granulata* Harger (fig. 165).

The Copepoda and Ostracoda are very abundant, both in the lots obtained in the trawl-wings and in the surface collections. Very many fine species were noticed, but they have not yet been reported upon by Mr. Rathbun, who has charge of these groups. He has studied a number of interesting and novel forms of Lerneans found parasitic on several of the deep-sea fishes. A representative of this group (*Antheacheres Dubenii* Sars, figs. 166, 167), which lives in the stomach of the large sea-anemone (*Bolocera Tuediæ*) has been referred to on a previous page [p. 12].

The Cirripeds were represented in deep water by several species of *Scalpellum* and allied genera, most of them of small size; one of these (*S. Strömii*) occurs frequently on the deep-sea gorgonian corals. Two or three species of this group live upon the large crab, *Geryon quinquedens*, some of them on the exterior and some in the gill-cavity. A large species of *Scalpellum*, allied to *S. regius* W. Thomson, was taken several times in deep water on Brown's Bank, off Nova Scotia; and large clusters of *Balanus Hameri* were dredged on the shallower parts of that bank.

PYCNOGONIDA.

The Pycnogonida were well represented by two or three very large species of *Colossendeis* and other genera, in 900 to 1,500 fathoms. Some of the largest of these (*C. colossea* Wilson, fig. 169) measured nearly 2 feet across the outstretched legs. Nine of them were taken at one haul in 1,106 fathoms. It is orange-colored in life.

ANNELIDA.

The Annelida are well represented at all depths, but yet they appear to be relatively much less numerous below 500 fathoms than in shallower water. In 100 to 300 fathoms they are usually abundant. The most conspicuous species, as well as one of the most abundant, is *Hyalinœcia artifex* V. (figs. 177–179*a*), which inhabits and drags about a large, quill-like, free tube, often 8 to 10 inches long, open at both ends, and so translucent as to show the large iridescent annelid within it. This is frequently taken in very large numbers, several thousands coming up in a single haul, in 150 to 640 fathoms. Two species of Actinians (*Sagartia abyssicola* and the young of *Actinauge nodosa*) are very often attached to these tubes, and also various hydroids and sponges.

There are also two or three large species of *Leodice* (*L. polybranchia* V., fig. 180, *L. vivida*, &c.), which inhabit irregular, rough, parchment-like tubes, very common in 100 to 300 fathoms. *Nothria conchyphila*

V., which constructs flat, free tubes, about 2 inches long, out of broken bivalves, often occurs in vast numbers in the warm zone.

A large and conspicuous, smooth, orange-red scaly annelid (*Polynoë aurantiaca* V., fig. 173), lives as a commensal among the tentacles of *Bolocera Tuediæ;* and another species of this group (*P. Acanellæ* V., fig. 172, *a–c*), is very abundant among the branches of *Acanella Normani.* It has a dark purple proboscis and finely spinulose scales. Numerous small species of many genera have been taken at great depths.

Several other interesting deep-sea annelids are illustrated on the plates (figs. 172–190).

GEPHYREA.

Several large and remarkable species of Gephyrea have been taken in deep water, but they are not yet determined. Among them there is a large strongly sulcated species (fig. 192), taken in 707 to 1,060 fathoms, which is often 3 to 5 inches long and nearly an inch in diameter, in alcohol. Another equally large species, from 858 to 1,168 fathoms, is covered with large warts or verrucæ. Both of these appear to be species of *Phascolosoma.* There is a large *Priapulus* (fig. 191, *a*) from 1,000 fathoms, and a small one from 1,060 fathoms. A large *Thalassema* occurred in 1,600 fathoms.

NEMERTEANS.

The nemertean worms are not common in deep water, and but few species have been taken in our deep-water dredgings. The largest and most interesting one is a bright orange species, which grows to the length of 10 feet or more, and is about a third of an inch in diameter. It occurred in 192 fathoms, and is identical with *Macronemertes gigantea* Verrill, originally from the Gulf of Maine. *Cerebratulus luridus* V. (fig. 195) occurred in 64 to 192 fathoms.

MOLLUSCA.

The Mollusca were very numerous and proved to be of even greater interest than those previously taken by the "Fish Hawk." The number of species of Mollusca added to the fauna of this region by the "Albatross" in 1883 was more than 150, of which over 80 were undescribed.*

Four new forms of Cephalopods were taken, including two new genera. One of these, from 2,949 fathoms, is an Octopod (*Eledonella pygmæa* V.), allied to *Eledone*, but peculiar in having the suckers singularly enlarged and altered in form on the hectocotylized arm (fig. 64). Another, from 1,731 fathoms, is a small squid (*Leptoteuthis diaphana* V., fig. 62), remarkable for its slenderness and transparency and for its

* Most of these new species are described by the writer in the Transactions of the Connecticut Academy, vol. vi, 1884, with figures.

very elongated head. The others are species of *Octopus*, from 142 and 1,290 fathoms.

Of Gastropods many new forms occurred. One of the most remarkable is a large shell, from 1,395 to 2,594 fathoms, the living ones only from below 2,000 fathoms, constituting a new genus (*Benthodolium abyssorum* V., fig. 84, *a*, *b*), allied to *Dolium*, but having an operculum, and in form somewhat resembling *Buccinum*. Its animal and dentition are, however, like *Dolium*. There was also a thin and delicate *Buccinum* (*B. abyssorum* V., fig. 80) of good size, the live ones ranging from 906 to 1,309 fathoms. Several interesting new forms of *Sipho* occurred. These are mostly small species, but some of them are of good size, as *S. profundicola* V. (fig. 81), living in 1,525 to 2,574 fathoms.

The curious and very beautifully sculptured shells belonging to the genus *Seguenzia* were among the most interesting forms. Two species were taken living. One of these is *S. formosa* Jefffreys (fig. 88), the other is a closely related new species, *S. eritima* V. (fig. 89). They both occurred several times in 1,290 to 2,033 fathoms. The possession of these species, with the animal preserved in alcohol, enabled me to study the dentition, and thus ascertain the zoological affinities of the genus. It proves to belong to the Tænioglossa, somewhere near *Aporrhais* and *Fossarus*, but evidently represents a new family (*Seguenzidæ* V.). It has no relationship whatever with Trochidæ, where it had been put by Boog-Watson and by Dall, nor with *Solaridæ*, where it was located by Jeffreys and others. The resemblance to these widely diverse groups is confined entirely to the shell, which is, however, very peculiar.

The Toxoglossa, as usual in deep water, were relatively very numerous, and included several handsomely sculptured new species belonging to *Pleurotomella* and allied genera. The largest of these is *P. Bairdii* (fig. 68), which is the largest member of this group known off our coast. It occurred living in 1,537 to 2,021 fathoms. Another remarkable and elegant species is *P. Catherinæ* (fig 76, *a*), from 843 to 2,033 fathoms. *P. Benedicti* (fig. 70, *a*), from 1,290 fathoms; *P. Emertoni* (fig. 74), from 1,917 fathoms; and *P. Bruneri* (fig. 75), from 1,608 to 2,033 fathoms, are also handsome shells, with the elegant and delicate sculpture and translucency characteristic of many deep-sea shells.

The Chitons or Polyplacophora are very scarce in deep water, perhaps owing to the small number of suitable objects to which they can adhere, for even the small limpets are generally found in worm-tubes, empty skate's eggs, or other similar places. Only five species of Chiton have been taken below 60 fathoms by us, and most of these also live in shallow water and do not go very deep. One was a very interesting new species (*Euplacophora Atlantica* V., figs. 102, 102*a*) belonging to a group not known before from the Atlantic. It is remarkable for the very broad anterior girdle.

The Rhiphidoglossa are well represented in deep water by several handsome species belonging to the Trochidæ, such as *Calliostoma Bairdii*

V. & S. (fig. 96), *Margarita regalis* V. & S. (fig. 97), *M. lamellosa* V. & S. (fig. 98), and by several small species of *Cyclostrema*. A more peculiar group includes curious small limpet-shaped shells, not distantly allied to *Fissurella*, but imperforate at tip. Of these we now know 10 species from our deep dredgings. These belong to the genera *Addisonia*, 1 species; *Cocculina*, 6 species; *Lepetella*, 1 species; *Propilidium*, 2 species.

The Tectibranchs are relatively abundant in deep water, one of the shell-less species, *Koonsia obesa* V. (fig. 107), grows to a very large size, some examples being 4 to 5 inches long and 3 broad. A large and handsome new *Scaphander* (*S. nobilis* V., fig. 106) was taken alive in 1,058 to 1,309 fathoms.

The Scaphopods are much more numerous in deep than in shallow water, and are abundantly represented by several species of *Dentalium*, *Siphodentalium*, and *Cadulus* (fig. 126). *D. solidum*, from 843 to 1,309 fathoms, grows to the length of 3½ inches. *Cadulus grandis* V. and another allied new species (*C. princeps* V.) are remarkably large representatives of this genus. The former lives in 816 to 1,537 fathoms, the latter in 1,525 to 1,594 fathoms.

Of Heteropoda, eight species were taken, including at least six species of *Atlanta* (figs. 110, 111). Part of these were only dredged as dead shells, but others were taken alive at the surface. Two transparent species of *Firola* (fig. 112) and *Firoloides* were common at the surface, associated with *Sagitta*, which it somewhat resembles in shape. All these species, except one, and most of the twenty-three Pteropods have long been known from the more tropical parts of the Atlantic, but not from so far north.

The bivalves or Lamellibranchs are relatively less abundant than in shallow water, and are less peculiar; but they include numerous species of the Anatinidæ and Corbulidæ (especially the genus *Neæra*), the Nuculidæ, including the genera *Nucula*, *Leda*, *Yoldia*, *Glomus*, *Malletia*, &c.; and the Arcidæ, including *Arca* and *Limopsis*. The Lucinidæ are also well represented by several species of *Cryptodon* (or *Axinus*) and other genera. Among the most peculiar forms are *Pholadomya arata* (figs. 133, 134), *Mytilimeria flexuosa* (fig. 132), *Verticordia cœlata* (fig. 131, *a*), and *Poromya sublevis* (fig. 128). Several species of *Pecten* and *Amussium* also occur, most of them with delicate, translucent, and elegantly sculptured shells (figs. 141, 142).

Of the Brachiopoda we took two deep-sea species, both new to our coast, but known on the European side. These are *Waldheimia cranium*, in 1,362 fathoms, and *Discina Atlantica*, in 1,251 to 1,467 fathoms.*

The accompanying tables will give an idea of the number and bathymetrical distribution of the different groups of Mollusca.

The writer's published list† of the Mollusca taken in 1880 to 1883 by

*An additional species was obtained in 1884: *Atretia gnomon*, in 1,525 to 1,594 fathoms.

†Transactions Connecticut Academy, vol. vi, p. 263, 1884.

the "Fish Hawk" and "Albatross," off our northern coast, exclusive of those dredged only in shallow water, included 380 species and 21 named varieties. But of these, at least 42 are pelagic species, taken either alive at the surface or dead at the bottom, viz: Cephalopoda, 2; Tænioglossa, 1; Ptenoglossa, 1; Nudibranchiata, 4 (2 live also in shallow water); Heteropoda, 8; Pteropoda, 24; Lamellibranchiata, 3 (2 live also in shallow water). Possibly a few other species, now considered as deep-water forms, may be pelagic, for it is difficult to tell at what depths free-swimming species of Cephalopods are taken, unless they occur in the stomachs of the deep-sea fishes. Many small Gastropods, &c., living habitually on floating *Fucus* and *Sargassum*, are caught with these sea-weeds in the trawl, on its way up or down, and mingling with the shells from the bottom may give rise to errors of this kind. Thus some of the species of *Rissoa*, *Cingula*, *Cithna*, &c., may not really live at the depths recorded, but at the surface. There were also a considerable number of minute, undetermined species not included in the list. During the season of 1884 about 40 species, of which about 25 were undescribed, were added to this list. These are largely from the deepest dredgings.

Of the 343 species* and 20 named varieties in my published list of 1883, regarded as living at the bottom, 89 are also shallow-water forms, living habitually in less than 60 fathoms, in this region. A considerable number, considered as deep-water species on this part of the coast, occur in shallow water north of Cape Cod, and some of them may eventually be found to occur in the cold belt off Martha's Vineyard in 25 to 60 fathoms. Of the shallow-water species, 63 occur also between 200 and 500 fathoms, and 18 below 1,000 fathoms. Some of these have a remarkable great range geographically, as well as in depth. Of the 273 species and varieties regarded as belonging to the deep-water fauna in this region, 143 have occurred in the comparatively warm zone, between 60 and 200 fathoms. A considerable number of these have been taken only in the more southern dredgings, off Chesapeake Bay and Cape Hatteras, and some of them only in depths not much exceeding 100 fathoms, where the Gulf Stream has the greatest effect. In this zone occur species belonging to southern genera, such as *Dolium Bairdii* (fig. 83), *Marginella borealis* (fig. 79), *Solarium boreale* (figs. 95, 95*a*), *Avicula hirundo*, &c.

The number that occupy the zone between 200 and 500 fathoms is 128, while 118 inhabit the depths between 500 and 1,000 fathoms, and 96 have been taken between 1,000 and 2,000 fathoms. Although but five of our dredgings have been in more than 2,000 fathoms,† we are able to

* More recent studies of the 1883 shells have added several species to the list, mostly from the deeper localities. They are included in the accompanying list.

† During the season of 1884 other series of dredgings were made in the same region in depths below 2,000 fathoms. From these a large number of additional species of Mollusca and other groups were obtained.

enumerate 34 species from between 2,000 and 3,000 fathoms, which is a much greater number than had previously been recorded from such depths in the North Atlantic.

The species and varieties already described as new from the 1883 collections are 76, as follows: Cephalopoda, 4; Gastropoda, 58; Solenoconcha, 4; Lamellibranchiata, 10. The total number of species of Mollusca added to the fauna of this region by the Fish Commission dredgings since 1880 is over 275.

The different groups of Mollusca differ greatly in the relative proportion of deep and shallow water species, as shown by the following tables. Thus the deep-water Cephalopods are 23, against 4 shallow-water and surface species. The Gastropods exclusively deep water are 166, against 38 of shallow-water origin. The shallow-water Lamellibranchs, however, seem to have a much greater tendency to range into deep water, for of these there are but 68 deep-water species and varieties, associated with 46 shallow-water ones.

TUNICATA.

On the upper part of the Gulf Stream slope, at the depths of about 65 to 125 fathoms, in localities where the bottom is of compact sand and gravel, it is often well covered with various sponges, hydroids (*Tubularia*, *Cladocarpus*, &c.), and large, rough groups of a coarsely wrinkled ascidian, which appears to be identical with *Cynthia partita* Stimpson. This species occurs abundantly in shallow water on stones, piles, &c., from North Carolina to Vineyard Sound, often forming, in such situations, large, irregular clusters. A few other species, not yet studied, also occur, though less commonly, on the hard bottoms in 100 to 125 fathoms. At the northern stations, off Nova Scotia, where the bottom is often stony, many of the well-known northern forms occur, such as *Boltenia Bolteni*, *Ascidia complanata*, *Cynthia pyriformis*, &c. In the deeper waters, where the bottom is usually of soft mud and sand, or ooze, ascidians are not very common, though several undetermined species of *Molgula* and allied forms have been taken. One species of *Molgula*, which was taken in 1,608 fathoms, is about an inch in diameter, soft, flattened, and covered with a thick coat of foraminifera.

The most interesting ascidian taken by us is a new species of the curious, long-stemmed genus, *Culeolus*, first discovered by the "Challenger." It is peculiar to deep water, and a species very closely allied to our own was dredged by the "Challenger" off the coast of Japan. I have named our species *Culeolus Tanneri* (figs. 144, 145, *a. b.*),* in honor of our accomplished commander.

* *Culeolus Tanneri* Verrill, sp. nov. Stem long, slender, somewhat decreasing in size from the base to the summit. Body irregularly pear-shaped, the lower end tapering to a conical form, where it joins the stem, while the stem itself can be seen extending upward about 15 to 20^{mm} along the dorsal margin, where it forms, for that distance, a rounded midrib terminating in a prominence in one specimen and at a de-

Several fine species of *Salpa*, some of them of great size, often occurred in abundance in our trawl, but they belong to the surface fauna, and will be mentioned more particularly under that head.

BRYOZOA.

The Bryozoa collected have not yet been carefully studied. They are usually not abundant in deep water, owing mainly to the absence of favorable objects for attachment. Whenever we have met with bowlders or hard concretions in deep water we have generally found a number of species of Bryozoa adhering to them. On the hard, spongy bottoms, in 65 to 125 fathoms, several species commonly occur, mixed with the hydroids and sponges, or adhering to ascidians, shells, pebbles, &c. One of the most interesting of these is a slender species of *Salicornaria*.

On the stony bottoms off Nova Scotia, in about 100 fathoms, large numbers of well-known northern species were taken. On stones and hard concretions, taken at station 1124, in 640 fathoms, there are several species, among which are *Cellularia scabra*, *Discopora ovalis*, and a *Tubulipora*. The two latter also occurred on stones from 234 fathoms, with *Membranipora Flemingii* and other species. The curiously branched form, *Kinetoskias* (or *Bugulopsis*) *flexilis* V., occurred in 194 fathoms.

SPONGES.

The sponges obtained in this region have not yet been studied. Those from deep water are not very numerous, but some of them are of great interest. One large handsome, vase-like, vitreous sponge, resembling *Holtenia*, was taken at station 2067, in 122 fathoms, off Nova Scotia. A thin, felt-like species, belonging to the same group, occurred in 640 to 780 fathoms. A large, coarse-fibered, felt-like *Phakellia*, growing in semicircular or funnel-shaped fronds, was taken in 640 fathoms, together

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pression in another. The dorsal margin is nearly straight, but swells out a little in the middle, and is subcarinate, with a row of small scattered papillæ along the ridge. The distal end is large, rounded, swollen, and bordered on each side by a distinct keel, which is covered with several crowded rows of prominent, rough, though soft papillæ, which merge into a large, triangular patch of similar but larger papillæ, situated on the dorsal side near the distal end, where the dorsal carina meets the lateral ones; the papillæ in this cluster are large, stout, tapering to a point, and covered on all sides with minute, conical spinules. The lateral rows of papillæ extend back to about the middle of the body on the ventral side, where they meet, thus inclosing a large ovate area, near the middle of which the large cloacal-opening is situated. This opening is bilabiate, each lip bordered with one or two rows of elongated, rough papillæ, like those of the lateral carinæ. The oral opening is very large, in expansion nearly round, the proximal side sometimes bending inward, leaving a sinus on either side of it; the margin is thickened and revolute, bordered by a row of small tapering papillæ. The whole surface of the test is covered by minute, granule-like or conical elevations, which are rather close over the dorsal parts, less numerous beneath. Color dull yellowish gray, the stem dark brown.

Length of the stem of one specimen, 155^{mm}; its diameter near the base, 2^{mm}; length of body, 70^{mm}; greatest diameter, 400^{mm}; diameter of mouth, 8^{mm}. Station 2041, in 1,608 fathoms, 1883.

with a slender pinnate species of *Cladorhiza* (*C. abyssicola* Sars ?). The large, stout, clavate, species (*C. grandis* V., fig. 1), occurred occasionally. It is not uncommon in 100 to 200 fathoms off Nova Scotia. The curious slender-stemmed *Stylocordyla longissima* G. O. Sars, was dredged on muddy bottoms several times in 407 to 1,423 fathoms. *Dorvillia echinata* Verrill, which forms large, harsh, spiculose balls, attached to the mud by long root-spicules, occurred in one instance.

On the hard bottoms in 65 to 125 fathoms several irregularly lobed and branched species, belonging to *Chalina*, *Isodictya*, *Halichondria*, &c., occurred in great abundance. With these there were large numbers of hard, rigid, sparingly branched and rather strong stems of an unknown sponge, composed of long closely-united siliceous spicules.

FAUNA OF THE NORTHERN WATERS.

One trip, stations 2053 to 2084, was made to the northern waters, during which a number of hauls were made, both in shallow and deep water, on and near Brown's Bank, off Cape Sable, Nova Scotia, and off the southern slope of George's Bank, August 29 to September 5. On the southern border of Brown's Bank a rough, hard bottom, covered with stones and large barnacles, was found in 108 to 113 fathoms (stations 2069 to 2071), on which the great bush-coral (*Primnoa lepadifera*) appeared to be abundant, and several good specimens of it were obtained by the use of tangles and grapples, but the bottom was too rough for the trawl. Various other well-known northern and Arctic species, most of them already discovered in the same region by our former explorations, were obtained from the cold-water localities, many of which were in moderate depths. Great clusters of the large barnacle (*Balanus Hameri*) were dredged in abundance in 80 to 120 fathoms on Brown's Bank. It was usually associated on these rough, stony bottoms with *Balanus porcatus*. Among the more prominent of the northern Echinoderms taken in these northern waters were *Solaster endeca*, *Crossaster papposus*, *Lophaster furcifer* (fig. 49, *a*), *Ophiacantha spectabilis*, and several new species of *Ophiacantha* enumerated in the general list.

One interesting Arctic shell was added to the American fauna on this occasion. This is a limpet-like species (*Piliscus commodus* Midd.) previously known from the extreme northern coasts of Europe and Asia, from Iceland, and from Alaska. It was dredged in the same region as the *Primnoa*, in 150 fathoms, and lives clinging closely to the rocks. Doubtless other additions to our northern fauna will be found among these northern dredgings when they shall have been carefully studied.

On the hard bottoms, covered with barnacles, &c., in about 100 fathoms, off Nova Scotia, several northern species of sponges were obtained, mostly of *Halichondria*, *Chalina*, and allied genera. Among these were *Chalina oculata*, *Polymastia robusta*, &c.

The fauna in the deep-water localities dredged on the same trip (stations 2072 to 2078, 2083, 2084) did not differ essentially from that found atrrco esponding depths off Martha's Vineyard.

LIST OF ANTHOZOA DREDGED BY THE "ALBATROSS" IN* 1883.

ALCYONARIA.

Pennatula aculeata Kor. & Dan. Figs. 7, *a*, *b*.
B. range, 97 to 1,255 fathoms, 1883. Abundant locally.

Pennatula aculeata, var. *rosea* Kor. & Dan.
B. range, 157 to 410 fathoms (197 fathoms, 1883). Rare.

Pennatula (*Ptilella*) *borealis* Sars. Figs. 8, 8*a*.
B. range, 192 to 1,255 fathoms (204 to 1,255 fathoms, 1883). More common off Nova Scotia.

Benthoptilum sertum Verrill. Fig. 4.
B. range, 843 to 1,073 fathoms (843 fathoms, station 2115, off Cape Hatteras, 1883). Rare.

Balticina Finmarchica (Sars) Gray. Figs. 11, 11*a*.
B. range, 164 to 858 fathoms (197 to 858 fathoms, 1883). Not rare; common off Nova Scotia.

Anthoptilum grandiflorum Verrill. 1879. Fig. 9.
B. range, 302 to 1,731 fathoms (1,098 to 1,731 fathoms, 1883). Scarce and local; common off Nova Scotia.

Anthoptilum Murrayi Kölliker.
B. range, 640 to 1,362 fathoms (843 to 1,362 fathoms, 1883). Common locally.

Funiculina armata Verrill. 1879.
B. range, 252 to 1,362 fathoms (1,050 to 1,362 fathoms, 1883). Not uncommon.

Kophobelemnon tenue Verrill. 1884. Fig. 5, *a*.
B. range, 1,362 to 2,369 fathoms, 1883. Not common; local.

Kophobelemnon scabrum Verrill. 1883.
B. range, 499 to 788 fathoms, 1883. Not common; abundant locally in 1884.

Umbellula Bairdii Verrill. 1884. Fig. 2.
B. range, 1,731 to 2,033 fathoms, 1883. Not common; local.

Umbellula Guntheri Kölliker. Fig. 3.
B. range, 1,731 to 2,033 fathoms, 1883. Not common; local.

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* The following paper on the "Blake expedition" Anthozoa contains descriptions and figures of many of the deep-sea species by the writer:

Report on the Anthozoa, and on some additional species dredged by the "Blake" in 1877-'79, and by the U. S. Fish Commission steamer "Fish Hawk" in 1880-'82. From the Bulletin of the Museum of Comparative Zoölogy, vol. xi, No. 1, July, 1883.

Many species are also described by the writer in "Brief Contributions to Zoölogy from the Museum of Yale College" in the American Journal of Science, 1878 to 1884; and others in the Proc. U. S. National Museum, vol. ii, pp. 165-205, 1879.

Protoptilum aberrans Kölliker.
B. range, 861 to 1,290 fathoms (1,098 to 1,290 fathoms, 1883). **Rare.**

Distichoptilum gracile Verrill. 1882.
B. range, 780 to 1,050 fathoms (1,050 fathoms, 1,883). Rare.

Scleroptilum gracile Verrill. 1884. Fig. 6.
B. range, 1,467 to 2,369 fathoms, 1883. Abundant locally.

Renilla reniformis Cuv.
B. range, shore to 15 fathoms, off Cape Hatteras, 1883.

Acanella Normani Verrill. 1878.
B. range, 105 to 1,731 fathoms, 1883. Very common and abundant.

Lepidisis caryophyllia Verrill. 1883.
B. range, 1,098 to 1,735 fathoms, 1883. Common.

Keratoisis ornata Verrill. 1878.
B. range, 150 to 300 fathoms off Nova Scotia; 858 fathoms, 1883, off Cape Sable; dead joints. Northern; not rare off Nova Scotia.

Lepidogorgia gracilis Verrill. 1884. Fig. 10.
B. range, 858 to 1,735 fathoms, 1883. Locally abundant.

Dasygorgia Agassizii Verrill. 1883.
B. range, 1,346 fathoms, 1883. Rare and local.

Paramuricea borealis Verrill. 1878.
B. range, 101 to 855 fathoms, 1883. Not rare; common northward.

Acanthogorgia armata Verrill. 1878.
B. range, 407 to 640 fathoms (407 fathoms, 1883). More common off Nova Scotia, in 150 to 300 fathoms.

Primnoa reseda (Pallas) Verrill.
B. range, 101 to 131 fathoms, 1883. Northern; not taken south of Brown's Bank, Nova Scotia.

Anthomastus grandiflorus Verrill. 1878. Fig. 12.
B. range, 75 to 1,395 fathoms, 1883. Local; common off Nova Scotia.

Gersemia longiflora Verrill. 1883.
B. range, 858 to 1,917 fathoms, 1883. Locally abundant.

Eunephthya Lütkeni (Marenz.) Verrill.
B. range, 858 to 1,497 fathoms, 1883. Not common; chiefly northern.

Alcyonium multiflorum Verrill. 1879.
B. range, 130 to 300 fathoms, off Nova Scotia (131 to 239 fathoms, 1883). Common off Nova Scotia.

Alcyonium carneum L. Agassiz.
B. range, 8 to 55 fathoms (13 fathoms, 1883). Abundant locally in 15 to 30 fathoms.

Cornulariella modesta Verrill. 1874.
B. range, 80 to 150 fathoms (80 fathoms, 1883, off Cape Sable). Entirely northern.

ACTINARIA.

Adamsia sociabilis Verrill. 1882. Fig. 26.
B. range, 79 to 410 fathoms (98 fathoms, 1883). Abundant locally.

Sagartia abyssicola (Kor. & Dan.) Verrill. Fig. 177.
B. range, 69 to 640 fathoms (131 to 487 fathoms, 1883). Abundant.

Sagartia Acanellæ Verrill. 1883. Fig. 25.
B. range, 252 to 1,608 fathoms (407 to 1,608 fathoms, 1883). Abundant on Acanella.

Sagartia spongicola Verrill. 1883.
B. range, 79 to 317 fathoms (81 to 179 fathoms, 1883). Abundant on spongy bottom.

Synanthus mirabilis Verrill. 1879.
B. range, 150 to 333 fathoms. Common off Nova Scotia.

Urticina crassicornis Ehr.
B. range, 16 to 141 fathoms (49 to 141 fathoms, 1883, George's and Brown's Banks). Abundant northward in shallow water.

Urticina perdix Verrill. 1882. Fig. 19, *a*.
B. range, 62 to 192 fathoms (62 fathoms, 1883). Common locally.

Actinauge longicornis Verrill. 1882. Fig. 21.
B. range, 100 to 325 fathoms (142 to 197 fathoms, 1883). Not uncommon.

Actinauge nexilis Verrill. 1883. Figs. 22, 22*a*.
B. range, 168 to 245 fathoms (197 fathoms, 1883). Common.

Actinauge nodosa (Fabr.) Verrill. Fig. 20.
B. range, 86 to 1,098 fathoms (122 to 1,098 fathoms, 1883). Abundant and generally diffused.

Actinauge consors Verrill. 1882. Fig. 161.
B. range, 164 to 458 fathoms. Local; not common.

Actinostola callosa Verrill. 1882. Fig. 24.
B. range, 55 to 640 fathoms (99 to 239 fathoms, 1883). Common.

Actinernus nobilis Verrill. 1879. Figs. 23, 23*a*.
B. range, 1,068 to 1,582 fathoms, 1883. Rare; common off Nova Scotia in 200 to 300 fathoms.

Bolocera Tuediæ Gosse.
B. range, 37 to 1,106 fathoms (65 to 1,106 fathoms, 1883). Generally distributed and abundant.

Cerianthus borealis Verrill. 1873.
B. range, 60 to 264 fathoms (99 fathoms, 1883). Not uncommon; but adults are rarely dredged.

Epizoanthus Americanus Verrill. 1864.
B. range, 26 to 547 fathoms (35 to 547 fathoms, 1883). Generally diffused and very abundant.

Epizoanthus Americanus Verrill (encrusting variety).
B. range, 49 to 906 fathoms, 1883. Abundant.

Epizoanthus paguriphilus Verrill. 1882. Fig. 28.
B. range, 252 to 640 fathoms (499 fathoms, 1883). Abundant locally. This large species, in all cases observed, has formed the carcinœcia of *Parapagurus pilosimanus*. The surface is smooth and glaucous, dark bluish gray in alcohol, and often partly covered with fine mud.

Epizoanthus abyssorum Verrill. 1885. Fig. 27.
B. range, 1,555 to 2,033 fathoms, 1883. Common.

This species generally forms the carcinœcia of *Parapagurus pilosimanus*, but sometimes consists of two or three large obconic polyps arising from a grain of sand. In the former case there are four to six divergent marginal polyps, usually with an odd one above and beneath. The polyps are large, usually clavate in contraction, with twenty-four convergent ridges at the summit. The surface is closely covered with small foraminifera, mixed with some sand grains. Color grayish white, purple or orange tinted at summit. Length of largest polyps, in contraction, 10 to 13^{mm}; diameter, 9 to 11^{mm}.

MADREPORARIA.

Flabellum Goodei Verrill. 1878. Fig. 14.
B. range, 75 to 888 fathoms, 1883. Common.

Flabellum angulatum Moseley. Fig. 15.
B. range, 906 to 1,467 fathoms, 1883. Not common; local.

Caryophyllia communis (Seguenza) Moseley. Fig. 16.
B. range, 1,022 to 1,106 fathoms, 1883. Not common; local.

Paracyathus granulosus Verrill. 1885.
B. range, 1,091 fathoms, 1883. Not common.

Dasmosmilia Lymani Pourt. 1871. Fig. 17.
B. range, 65 to 179 fathoms, 1883. Common locally.

Oculina implicata Verrill. 1864.
B. range, 14 fathoms, off Cape Hatteras, 1883.

SPECIES PREVIOUSLY DREDGED BY THE "FISH HAWK" 1880 *TO* 1882, *BUT NOT OBTAINED IN* 1883.

Pennatula aculeata, var. *alba* Verrill. 1883.
B. range, 216 fathoms, 1882. Very rare.

Virgularia Ljungmani Köll.? (young.)
B. range, 487 fathoms, 1880. Rare.

Anthothela grandiflora (Sars) Verrill.
B. range, 255 fathoms, station 1031, 1881. Local; common off Nova Scotia.

Actinernus saginatus Verrill. 1882.
B. range, 458 fathoms, station 1029, 1881. Rare.

Bolocera multicornis Verrill. 1882.
B. range, 33 to 90 fathoms, 1879, 1881. Local, northward, off Cape Cod.

Edwardsia farinacea Verrill. 1866.
B. range, 146 fathoms, station 1038, 1881. Not common; frequent in shoal water northward.

Bathyactis symmetrica (Pourt.) Moseley.
B. range, 225 to 252 fathoms, 1880. In 32 to 2,900 fathoms, "Challenger" expedition.

ADDITIONAL DEEP-SEA SPECIES DREDGED BY THE "ALBATROSS" IN 1884.

Stylatula, sp.
Station 2171, in 444 fathoms. Rare.

Stenogorgia casta Verrill. 1883.
Station 2220, in 1,054 fathoms; "Blake" expedition, 337 fathoms, off Georgia.

Phellia, sp.
B. range, 991 to 2,516 fathoms.

Desmophyllum cristagalli Edw. & Haime.
B. range, 1,054 to 1,060 fathoms. Rare.

Lophohelia prolifera Edw. & Haime.
B. range, 100 to 300 fathoms, off Nova Scotia; 1,060 fathoms, dead, 1884. Rare.

PARTIAL LIST OF DEEP-WATER HYDROIDA.

The following list includes only the more conspicuous and common forms. Many others have been taken, but the collection has not yet been carefully examined:

Monocaulus glacialis (Sars) Allman.
Corymorpha pendula Agassiz.
Occasionally taken on muddy bottoms in 30 to 182 fathoms.

Eudendrium, sp.
Not uncommon.

Dicoryne flexuosa Sars.
Not rare on stones and shells in 20 to 80 fathoms.

Tubularia indivisa L. (?)
Abundant in 65 to 158 fathoms, on hard bottoms of sand and gravel, among sponges.

Tubularia (?) sp.
Simple, cornucopia-shaped, yellow stems. B. range, 1,525 to 1,731 fathoms, on Gorgonians.

Hydractinia echinata Johnst.
Common from low water to 60 fathoms.

Nemertesia antennina Lx.
Not uncommon in 90 to 125 fathoms.

Cladocarpus flexilis Verrill, sp. nov. Fig. 29.
Common in 65 to 130 fathoms, on hard bottoms, with sponges.

Plumularia gracillima G. O. Sars.
Not rare in 70 to 125 fathoms.

Thuiaria, sp.
Not common.

Sertularia cupressina Linné.
Common in less than 100 fathoms.

Calicella plicatilis (Sars) Hincks. Fig. 30.
Common in 100 to 351 fathoms.

Cuspidella grandis Hincks.
Not common.

Opalorhiza parvula Allm.
Not common.

Halecium Beanii ? Johnst.
Not rare.

Halecium filicula Allm.
Not common.

Halecium sessile Norm.
Rather rare.

Lafoëa dumosa Sars.
Common at moderate depths.

Clytia Johnstoni Hincks.
Common at moderate depths and at the surface.

Campanularia, sp.
Not common.

Campanularia, sp.
A very slender form. Station 2037, in 1,731 fathoms.

Obelia dichotoma ? Hincks.
Not common.

Obelia longicyatha ? Allm.
Not uncommon on worm-tubes, &c., in 100 to 200 fathoms.

LIST OF ECHINODERMATA DREDGED BY THE "ALBATROSS" IN 1883.*

In this list a few northern species are included that were taken in comparatively shallow water, on George's Bank and Brown's Bank, off Cape Sable, Nova Scotia, and are not yet known from the deep water farther south.

HOLOTHURIOIDEA.

Benthodytes gigantea Verrill. 1884. Figs. 31, 31*a*, 31*b*.
B. range, 938 to 2,033 fathoms, 1883. Locally very abundant.

Euphronides cornuta Verrill. 1884. Figs. 32, 33, 33*a*.
B. range, 855 to 1,735 fathoms, 1883. Locally abundant.

Lophothuria Fabricii Verrill. Figs. 34, *a*, young.
B. range, 16 to 1,168 fathoms (75 to 858 fathoms, 1883, George's Bank and off Nova Scotia). Scarce and small, except northward.

Lophothuria squamata (Müll.) Verrill (?)
B. range, 80 fathoms, 1883, off Nova Scotia. Rare.

Psolus phantapus (Fabr.) Oken.
B. range, 86 fathoms, 1883, near George's Bank. Northern.

Pentacta frondosa Jæger.
B. range, 20 to 141 fathoms (86 to 141 fathoms, 1883, near George's Bank) Not common south of Cape Cod; abundant from Maine northward.

Pentacta minuta (Fabr.) Verrill.
B. range, 60 to 101 fathoms, 1883, off Nova Scotia. Common from Maine northward in shallow water.

Thyone scabra Verrill. 1873.
B. range, 51 to 640 fathoms (105 to 547 fathoms, 1883). Common.

Trochostoma turgida Verrill, = *Molpadia turgida* Verrill. 1879.
B. range, 45 to 858 fathoms, 1883. Not uncommon.

Trochostoma Ayresii Verrill. 1885.
B. range, 1,467 to 2,033 fathoms, 1883. Not uncommon.

Trochostoma abyssicola Verrill. 1885.
B. range, 1,200 to 2,000 fathoms. Not uncommon.

Echinosoma abyssicola Verrill, sp. nov. 1885.
B. range, 2,033 fathoms, 1883. More frequent in 1884.
A small, white, fusiform species, 15 to 20^{mm} long, entirely covered with large, strong plates, each of which bears a conical spinule.

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*Many of the Echinoderms of this region have been described by the writer in "Brief Contributions to Zoology" in the American Journal of Science, 1878 to 1885. See also Proc. U. S. Nat. Mus., vol. ii, 1879.

A general catalogue of the Echinoderms dredged from 1880 to 1882 is contained in Part x, of this report, p. 658, 1884.

Synapta brychia Verrill, sp. nov.

B. range, 938 fathoms, station 2111, off Cape Hatteras, 1883.

A large species, with a strong, thick, opaque purplish brown skin, as preserved in alcohol. The strong longitudinal muscles are lighter colored. The skin contains rather large, scattered, ovate plates, easily visible to the naked eye. They are perforated by numerous (seventy to eighty or more) small rounded openings, and have a central eminence, composed of several slender processes. Each plate bears a large anchor, its length equal to that of the plate. The shaft of the anchor is round and smooth, narrowed next the expanded end, which is surmounted by several rough or lacerate denticles; the flukes are long, sharp, smooth, strongly recurved, more than a third as long as the shaft. Many of the anchors project from the skin, and are large enough to be visible to the naked eye. Length, in alcohol, 160^{mm}; diameter, 10^{mm}.

ECHINOIDEA.

Pourtalesia Jeffreysii W. Thomson.

B. range, 843 to 1,555 fathoms, 1883. Not uncommon.

Aërope rostrata W. Thomson.

B. range, 1,395 to 1,608 fathoms, 1883. Local and not common.

Aceste bellidifera W. Thomson.

B. range, 1,395 to 1,497 fathoms, 1883. Not common.

Schizaster fragilis (Düben & Koren) L. Agassiz.

B. range, 37½ to 321 fathoms (99 to 239 fathoms, 1883). Common; locally abundant.

Schizaster Orbygnianus A. Ag.

Schizaster canaliferus, variety, Verrill, this report for 1882, part x, p. 658.

B. range, 65 to 179 fathoms (117 to 179 fathoms, 1883). Not uncommon; local.

Brissopsis lyrifera (Forbes) L. Agassiz.

B. range, 65 to 1,555 fathoms (938 to 1,555 fathoms, 1883). Common.

Urechinus Naresianus A. Ag.

B. range, 1,309 fathoms, 1883. Local; gregarious.

Echinarachnius parma Gray.

B. range, 6 to 888 fathoms (35 to 888 fathoms, 1883). Common; often very abundant in shoal water.

Phormosoma placenta W. Thomson.

B. range, 458 to 1,309 fathoms (499 to 1,309 fathoms, 1883). Common.

Phormosoma uranus W. Thomson.

B. range, 843 to 938 fathoms, 1883; 568 to 1,080 fathoms, 1884. Not common; local and gregarious.

Echinus gracilis A. Agassiz.

B. range, 73 to 202 fathoms (73 fathoms, 1883). Not uncommon; local.

Echinus Norvegicus Düben & Koren.

B. range, 888 to 1,497 fathoms, 1883. Common; often extremely abundant.

Echinus elegans Düben & Koren (?).

B. range, 858 to 888 fathoms, 1883.

Strongylocentrotus Dröbachiensis A. Ag.

B. range, 1 to 640 fathoms (35 to 141 fathoms, 1883, George's Bank and Brown's Bank). Common as far south as off Chesapeake Bay at moderate depths.

Salenia varispina A. Agassiz.

B. range, 547 fathoms, 1883. One specimen only.

Arbacia punctulata Gray.

B. range, shore to 20 fathoms (19 fathoms, 1883). Common in shallow water from Vineyard Sound southward.

ASTERIOIDEA.

Asterias Forbesii Desor.

B. range, shore to 20 fathoms (19 fathoms, 1883). Abundant from Massachusetts Bay southward.

Asterias vulgaris St. = *A. rubens* L. (?)

B. range, shore to 208 fathoms (41 to 86 fathoms, 1883, George's Bank and Brown's Bank). Abundant from off Long Island northward, in moderate depths. Ranges as far south as off Cape Hatteras.

Asterias Tanneri Verrill. 1880. Fig. 42, *a*.

B. range, 69 to 373 fathoms (78 to 373 fathoms, 1883). Common.

Asterias briareus Verrill. 1882.

B. range, 31 to 373 fathoms (78 to 373 fathoms, 1883). Rare.

Leptasterias compta (Stimp.) Verrill.

B. range, 18 to 150 fathoms (38 to 150 fathoms, 1883). Common and widely diffused; often very abundant in moderate depths.

Stephanasterias albula (Stimp.) Verrill.

Stichaster albulus Verrill, formerly.

B. range, 64 to 192 fathoms (69 to 117 fathoms, 1883). Common and widely diffused; locally abundant. Ranges from the Arctic Ocean and Northern Europe to Cape Hatteras.

Zoroaster Diomedeæ Verrill. 1884.

B. range, 98 to 1,555 fathoms, 1883. Common; sometimes abundant locally.

Brisinga elegans Verrill. 1884.

B. range, 906 to 1,395 fathoms, 1883. Local; not uncommon; gregarious.

Brisinga costata Verrill. 1884.

B. range, 888 to 1,255 fathoms, 1883. Not common.

One of the larger examples, from station 2116, but not the largest, measured 37 inches in diameter; disk, 2.75 inches; greatest breadth of arms, .75; length of longest spines, .62 of an inch.

Cribrella sanguinolenta (Müller) Lütken.

B. range, shore to 194 fathoms (69 to 122 fathoms, 1883). Common as far south as Cape Hatteras at moderate depths; abundant northward.

Solaster abyssicola Verrill. 1885.

Solaster Earllii Verrill, this Report for 1882, p. 659 (not of 1879).

B. range, 843 to 1,537 fathoms (843 to 1,395 fathoms, 1883). Not uncommon.

A large species, often a foot in diameter, somewhat resembling *S. Earllii*, but with very different spinulation on the actinal side. Rays usually eight or nine, varying to seven and ten. Abactinal side covered with rather small, not very close, rounded paxillæ, bearing small and short spinules. The branchial papulæ are large and numerous, thickly scattered on the disk and base of arms. Marginal plates prominent, bearing a transverse, oblong group of small rough spinules in two or three rows. Interbrachial ventral areas of moderate size, covered with rounded paxillæ similar to those of the back, but arranged in regular rows, and bearing a divergent group of five to eight small rough spinules. The adambulacral plates bear an outer transverse row of five to seven, rather short, moderately thick spines, united at base and covered by a thick skin; and an inner group of three or four nearly equal and rather short spines, united together by a web for about half their length. Color, while living, uniform orange or deep red. Greater radius of a medium sized example, 113^{mm}; lesser radius, 40^{mm}.

Solaster endeca Forbes.

B. range, shore to 150 fathoms, north of Cape Cod (122 fathoms, 1883, George's Bank). Common northward from Cape Cod in moderate depths.

Crossaster papposus M. and Tr.

B. range, shore to 150 fathoms, north of Cape Cod (49 to 75 fathoms, 1883, George's and Brown's Banks). Northern; common from the Bay of Fundy northward, in shallow water.

Lophaster furcifer (Dub. & Kor.) Verrill = *Solaster furcifer* auth. Figs. 49, 49*a*.

B. range, 234 to 640 fathoms (150 fathoms, 1883, George's Bank). Rare; chiefly northern; it occurs in moderate depths in the Gulf of Maine and off the Nova Scotia coast.

Pteraster militaris M. & Tr. Fig. 35.

B. range, 10 to 150 fathoms, north of Cape Cod (101 to 130 fathoms, in 1883, off Nova Scotia). Common on the coast of Maine and northward, in shallow water.

Diplopteraster multipes (Sars) Verrill. Fig. 43.
B. range, 124 to 640 fathoms (197 to 239 fathoms, 1883). Common and widely diffused as far south as off Cape Hatteras.

Hymenaster modestus Verrill. 1885.
B. range, 1,098 to 1,451 fathoms, 1883. Rare.

Porania grandis Verrill. 1879. Figs. 44, 44*a*, 45, 45*a*.
B. range, 66 to 373 fathoms, 1883. Not uncommon.

Poraniomorpha spinulosa Verrill.

Porania spinulosa Verrill, Proc. Nat. Mus., 1879, p. 202.

B. range, 86 to 640 fathoms (122 to 250 fathoms, 1883). Not uncommon.

Astrogonium granulare M. & Tr. Figs. 48, 48*a*.
B. range, 122 to 640 fathoms (122 fathoms, 1883, George's Bank). Rare south of Cape Cod; more common off Nova Scotia and northward.

Hippasteria phrygiana Gray=*H. plana* auth. Fig. 47, variety.
B. range, 30 to 150 fathoms, north of Cape Cod (50 to 150 fathoms, 1883, George's and Brown's Banks). Northern; common off Cape Cod, in the Gulf of Maine, off Nova Scotia, and northward.

Odontaster hispidus Verrill. 1880.
B. range, 56 to 487 fathoms (65 to 239 fathoms, 1883). Common; locally abundant.

Astropecten articulatus Say.
B. range, shore to 25 fathoms, south of Cape Hatteras (15 to 20 fathoms, 1883).

Archaster arcticus M. Sars.
B. range, 113 to 547 fathoms, 1883. Frequent, but only in small numbers.

Archaster Americanus Verrill. 1880.
B. range, 45 to 225 fathoms (65 to 197 fathoms, 1883). Common, widely diffused, and often very abundant.

Archaster Floræ Verrill. 1879. Fig. 36.
B. range, 86 to 410 fathoms (197 to 239 fathoms, 1883). Common, and widely diffused; locally abundant.

Archaster robustus Verrill. 1884.
B. range, 938 to 1,467 fathoms, 1883. Not rare in the deeper dredgings.

Archaster grandis Verrill. 1884.
B. range, 1,106 to 2,033 fathoms, 1883. Common; very abundant locally.

Archaster Agassizii Verrill. 1880.
B. range, 182 to 1,342 fathoms (499 to 1,342 fathoms, 1883). Common and widely diffused; locally sometimes very abundant.

Archaster Parelii Düben & Koren. Fig. 37.

B. range, 225 to 1,608 fathoms (547 to 1,608 fathoms, 1883). Not rare, but always in small numbers.

Archaster formosus Verrill. 1884.

B. range, 1,467 to 1,608 fathoms, 1883. Not common.

Archaster tenuispinus Düben & Koren. Fig. 38.

B. range, 368 to 1,731 fathoms (888 to 1,731 fathoms, 1883). Common; often abundant locally.

Archaster sepitus Verrill. 1885.

B. range, 368 to 858 fathoms (858 fathoms, 1883). Rare.

Benthopecten spinosus Verrill. 1884.

B. range, 855 to 1,917 fathoms, 1883. Common; locally abundant.

Luidia elegans Perrier. 1876 (Verrill, 1880). Figs. 39, *a*.

B. range, 53 to 192 fathoms (65 to 70 fathoms, 1883). Common; sometimes abundant locally.

Luidia clathrata (Say).

B. range, shore to 25 fathoms, south of Cape Hatteras (15 to 19 fathoms, 1883). Southern; common in shallow water.

Porcellanaster cæruleus W. Thomson. Figs. 40, 41.

B. range, 906 to 1,917 fathoms, 1883. Frequent; sometimes abundant.

OPHIUROIDEA.

Ophioglypha Sarsii (Lütk.) Lyman.

B. range, 30 to 1,608 fathoms (65 to 1,608 fathoms, 1883). Common, widely diffused; large and often very abundant at moderate depths in the course of the Arctic current, off Martha's Vineyard.

Ophioglypha signata Verrill. 1882.

B. range, 65 to 640 fathoms, 1883. Common in moderate depths.

Ophioglypha confragosa Lyman. 1878.

B. range, 238 to 2,033 fathoms (2,033 fathoms, 1883). Not common.

Ophioglypha bullata W. Thomson.

B. range, 1,608 to 2,221 fathoms, 1883. Not rare; local.

In respect to the large rounded scales of the disk, our larger specimens agree closely with the description of *O. convexa*, to which I at first referred them. Other characters agree better with *O. bullata*.

Ophioglypha lepida Lyman. 1878. Var. *spinulosa* Verrill. 1884.

B. range, 888 to 1,497 fathoms, 1883. Extremely abundant in several localities.

The disk is flat and thin; the scales thin, unequal, rather irregular in size, with curved margins; and there are small sharp spinules scattered over the disk. The arms are slender, and there is a single, longer, upper spine rather widely separated from the two lower and much smaller ones, close to the tentacle-scales.

Ophioglypha Ljungmani Lyman. 1878 (?).

B. range, 843 to 1,467 fathoms. Common.

This species is very closely allied to the preceding, and, like it, usually has, when perfect, a few small spines scattered on the disk; but the disk is much thicker, and the arms higher at base. The mouth-shields are larger and longer, emarginate laterally, disk scales coarser; the jaws more acute; mouth-papillæ, four or five, short, flat rounded, except the inner one.

Ophiomusium Lymani W. Thomson.

B. range, 238 to 2,033 fathoms (640 to 2,033 fathoms, 1883). Abundant and large in many localities.

Ophiomusium armigerum Lyman. 1878.

B. range, 1,731 to 2,369 fathoms, 1883. Abundant locally.

Ophiochiton grandis Verrill. 1884.

B. range, 888 fathoms, 1883. Rare.

Ophiomitra spinea Verrill. 1885.

B. range, 2,038 fathoms, station 2,035, 1883. Two specimens.

A large species resembling *O. valida*. Arms five, long and stout; disk five-lobed, indented between the arms; radial shields moderately large, irregularly ovate, with a small notch in the broad outer end; their inner ends are separated by a wedge of small scales, but the outer ends are in contact, or nearly so; disk-scales rather small, unequal, bearing small, low, conical spinules or granules; a few granules on the outer end of radial shields and bases of the arms. Arm-spines, eight or nine at base of arms, long, slender, acute, sharply thorny, arising from prominent side plates; the middle spines are the largest and roughest; the rows do not meet above at base of arms. Mouth-shields rhombic, with incurved lateral margins; the inner angle acute, the outer one obtuse or rounded; side mouth-shields thickened, crescent-shaped; tentacle-scale rather large, those at base of arm wide, flat, and obtuse; farther out lanceolate and rather acute. Mouth-papillæ numerous, unequal, rather irregular and crowded at the outer mouth-angles, where they form two or more rows; in the largest example there are eighteen to twenty, or more, in each angle; in the smaller one about twelve; they are mostly rather slender, spiniform, or papilliform, the outermost one wider and more flattened. The larger specimen has the disk 14^{mm} in diameter; the smaller one, 11^{mm}.

Ophiacantha bidentata (Retz.) Ljung.; Lyman (*pars*) "Challenger" Ophiuroidea.

Ophiacantha spinulosa (M. and Tr.) Lyman, Illus. Catalogue Mus. Comp. Zoology.

B. range, 40 to 351 fathoms (101 to 351 fathoms, 1883). Common northward, in moderate depths, from Massachusetts Bay to Greenland.

The form here intended is the same as that described and figured by

Lyman, Lütken, Duncan and Sladen, and others as *O. spinulosa*, from northern waters. Lyman's deep-water specimens, some of which I have examined, belong in part at least, to the following species.

Ophiacantha fraterna Verrill, sp. nov.

B. range, 908 to 1,608 fathoms. Common.

Disk rounded, rather swollen, with ten slightly raised radial ridges made by the radial shields, which have the outer ends small, a little prominent and naked. The surface of the disk is covered with very small, short, obtuse, rough spinules, terminated by several minute sharp thorns; usually mixed with these there are many small, rather rough conical granules, of about the same size. Arm-spines at base of arms about eight, longest on the second and third joints beyond the disk, but the rows are not closely approximated dorsally. The upper spines are long, very slender, acute, and but slightly roughened; the middle ones are a little thorny; the lower ones comparatively short. Tentacle-scale flattened, small, tapered, subacute. Ventral arm-plates narrow, about as long as broad, strongly convex on the outer margin, and with a distinct angle on the inner. Mouth-shields small, transversely cross-shaped, with a small outer lobe extending a little on the interbrachial spaces, and with a small, very obtuse angle on the inner margin, the side lobes much larger and more prominent. Side mouth-shields rather wide, somewhat crescent-shaped, strongly curved. Mouth-papillæ about three on each side, besides a larger one below the teeth; they are rather long, spiniform, and acute, the outer one not differing from the rest. Color in alcohol dull brownish yellow, usually with darker brown blotches on the arms and disk. Diameter of disk, usually 9 to 12^{mm}.

This species has hitherto been confounded with *O. bidentata*, which it resembles. It differs in the smaller size and different character of its disk-spinules, in the rougher spines, smaller and more acute tentacle-scales, and in the sharp, spiniform, outer mouth-papillæ. The mouth-shields have an outer lobe extending somewhat on the interbrachial spaces, though less so than in *O. millespina* and several other species.

Ophiacantha varispina Verrill, sp. nov.

B. range, 101 fathoms, off Nova Scotia.

Disk slightly five-lobed, covered on the central part with small, elongated, tapered, acute, rough spines, which are gradually replaced toward the margins by shorter and stouter, very rough, obtuse stumps, surmounted by a group of sharp, rough spinules; radial shields slightly exposed at the prominent outer end. Arms slender; the spines about eight, somewhat rough, glassy; the upper ones long, slender, acute, the rows nearly meeting on the second joint beyond disk; the lower ones are shorter and very slender; tentacle-scale flat, subspatulate, broadly rounded at the end. Ventral arm-plates near base of arms not much broader than long, rather pentagonal, the outer edge curved, or

subtruncate in the middle, the inner edge nearly straight or slightly angulated centrally. Mouth-shields strongly four-lobed, the inner angle acute, with concave sides, the lateral lobes prominent, subacute, the outer lobe smaller, obtuse, extending somewhat on the interbrachial area; side mouth-shields wide, not very long, somewhat crescent-shaped, the outer margin convexly arched to fit the concave sides of the mouth shield. Mouth-papillæ mostly flat and broad, lanceolate or obtuse, three or four on each side besides the infradental; a slender, smaller one often stands out of line, back of the outermost, which is flatter and more obtuse than the others. Color yellowish brown, with darker blotches on disk and arms. Diameter of disk, 9^{mm}; length of arms, 35^{mm}. Station 2069, in 101 fathoms, off Nova Scotia. Peculiar in the mixture of sharp spines and obtuse thorny stumps on the disk. General appearance much as in *O. bidentata*.

Ophiacantha granulifera Verrill. 1885.

B. range, 101 to 200 fathoms, off Nova Scotia.

Disk five-lobed, covered with small rounded and conical, slightly rough granules; radial shields form ten rather prominent ridges, naked only at the rounded and prominent outer end; interbrachial spaces beneath scaly, with few granules. Arms rather broad. Arm-spines eight to nine at base of arms, the rows not approximating dorsally; the upper ones are long, very slender, acute, slightly roughened; the middle ones are stouter and distinctly thorny; the lower ones much shorter; tentacle-scale small, lanceolate, subacute, except on the two first joints, where they are obtuse and flattened, and sometimes two together; side arm-plates broadly united ventrally; ventral arm-plates unusually broad and short, especially on the second to seventh joints, where they are transversly oblong, the outer margin nearly straight or slightly emarginate, the inner edge with a slight median angle; farther out they become longer, narrower, and somewhat trapezoidal. Mouth-shields small, somewhat cruciform, with a small outer lobe, an obtuse inner angle, and with acute lateral lobes. Side mouth-shields larger, broad, strongly curved, thickened, and minutely granulose. Mouth-papillæ all spiniform, three or four on each side, besides a larger one below the teeth. Color light brownish yellow, with darker blotches on the arms. Diameter of disk, 9^{mm} to 11^{mm}. Easily distinguished by the short, wide, ventral arm-plates and the small, close, granules on the disk.

Ophiacantha enopla Verrill. 1885.

B. range, 351 to 640 fathoms, 1882, 1883.

Easily distinguished by having numerous mouth-papillæ, the outer ones forming a crowded group at the end of the mouth-angles. The disk is covered with small obtuse or rounded granule-like stumps, slightly spinulated at the end. The arm-spines are long and slender, glassy, seven or eight near the base of the arms, forming a nearly continuous band on the dorsal side. Color in life, orange.

Ophiacantha abyssicola G. O. Sars.

B. range, 1,000 to 1,608 fathoms, 1883. Not uncommon. Very closely allied to the next, and perhaps identical.

Ophiacantha millespina Verrill. 1879.

B. range, 100 to 1,917 fathoms, 1883. Abundant and widely diffused.

Ophiacantha aculeata Verrill. 1885.

B. range, 1,346 to 1,395 fathoms, 1883.

A large species, with five unusually long, gradually tapering arms. Disk rounded and swollen, throughout evenly covered with small, slender, elongated spinules, having rough sides and terminated by four to six slender, rough, divergent points. These disk-spinules are less crowded, smaller, longer, and more slender than in *O. bidentata.* End of radial shields not exposed. Arm-spines very long, slender, nearly smooth, eight or nine at base of arms, those next to the edge of disk decidedly longer and forming an almost continuous band above. Tentacle-scales rather wide, but with acute tips at base of arms, rapidly becoming smaller and acute-lanceolate farther out. Mouth-shields rather small, rounded externally, and not extending much on the interbrachial spaces, obtuse-angled on the inner side. Jaws broader and more obtuse than in most species. Mouth-papillæ rather slender, usually three or four on each side of a jaw, besides the median one; the outer one is largest, broad and flat at base, rapidly narrowed toward the acute end; the next two are more slender, spiniform, and acute; sometimes an additional smaller one stands out of line, behind those in the regular row. Color, light orange or buff. Diameter of disk of a large example, 17^{mm}; length of arms, 110^{mm}. Stations 2034 and 2105, in 1,346 to 1,395 fathoms, on *Brisinga elegans* V.

Ophiacantha anomala G. O. Sars.

B. range, 101 to 131 fathoms, off Nova Scotia, 1883. Not common; chiefly northern.

This species is easily recognized by having regularly six arms. The disk is covered with rather large and coarse stump-like spinules, rough at the obtuse or rounded summit.

Ophiacantha spectabilis G. O. Sars.

B. range, 131 fathoms, off Nova Scotia, 1883. One specimen only.

This species has smoothish, tapering, acute spines on the disk. The mouth-papillæ are slender, tapering, and acute.

Ophiacantha crassidens Verrill, Amer. Journ. Sci., February, 1885.

B. range, station 2115, in 843 fathoms, off Cape Hatteras.

This large species is easily distinguished by its disk, covered with small, conical, acute spines, and by the remarkably large, rough, and thick mouth-papillæ, which are crowded. The arm-spines are rather short and blunt. The color is dark brown in alcohol.

Ophiacantha gracilis Verrill, sp. nov.

B. range, 220 to 858 fathoms, mostly off Nova Scotia, on Gorgonians.

A small, delicate species, with long, slender, attenuated arms. Disk round and full, covered with relatively large, easily visible scales, each of which bears a rather large and high columnar spinule, a little enlarged at the summit and terminated by five or six or more, slender, sharp, divergent points. Arm-spines along most of the length of the arm, four or five, short for the genus, being about half as long as an arm-joint; the small upper one is tapered; the lower ones are stouter, rough, blunt, and hooked at the end; the lowest is largest and most hooked; on the two joints next to the disk the five spines are much longer, very slender, tapered, acute; the two upper ones twice as long as an arm-joint. Tentacle-scale, small, spiniform; mouth-papillæ few, about three on each side of a jaw, besides a larger, odd, terminal one; the lateral ones are small, spiniform; the two outer ones stand a little back from the slit, like tentacle-papillæ; mouth-shields small, narrow, rounded without; acute, angular within; side shields, large, angular; ventral arm plates widely separated, elongated, rounded on the outer edge; the inner end with an angular median point. Diameter of disk, 3.5^{mm}; length of arms, about $.22^{mm}$. Probably young, but very unlike the young of any of our other species.

Ophiolebes Acanellæ Verrill, Amer. Journ. Sci., February, 1885.

B. range, 91 to 122 fathoms, off Nova Scotia.

Disk rounded, smaller, covered above and below with rather large globular or capitate stumps, minutely spinulose at the end. Arms short. Arm-spines at base of arms, six or seven, short, obtuse, rough, with small spinules; the four lower are shorter and stouter than the upper ones, with a blunt or clavate, rough, thorny tip; the upper ones are more cylindrical, but mostly blunt, shorter than the breadth of the arm-joint; the lower groups of three or four spines extend nearly to the mouth-angles. Mouth-papillæ, three or four on each side, small, nearly equal, rounded, obtuse. Diameter of disk, 6^{mm}. Station 2071, on *Paramuricea borealis*, in 113 to 122 fathoms, off Nova Scotia.

Ophiopholis aculeata Gray.

B. range, shore to 1,000 fathoms (18 to 1,000 fathoms, 1883). Very common and widely diffused as far south as off Cape Hatteras.

Amphiura Otteri Ljungmann (?); Lyman.

B. range, 182 to 1,608 fathoms (487 to 1,608 fathoms, 1883). Not uncommon.

In this species the disk is covered with small scales, above and below; the radial shields are elongated, wedge-shaped, with a narrow group of scales between their divergent and tapered inner ends. The arms are very long and rather slender, flattened, usually with about six spines toward the base, but in large specimens there may be as many as eight; they are moderately long, tapered, and, except the upper

ones, mostly a little bent toward the end, with the tip slightly hooked. Two flat, blunt tentacle-scales, which are very small and indistinct in young specimens; a pair of stout mouth-papillæ at the end of each jaw, and one smaller spiniform one on each side, a little farther back; a stout, erect, spiniform tentacle-papilla at the outer end of the mouth-slit on each side.

Amphiura fragilis Verrill, sp. nov.

B. range, 239 to 1,467 fathoms.

Disk, five-lobed, covered above with small, delicate scales, naked beneath; radial shields, pear-seed-shaped, slightly divergent, the inner ends separated by a narrow row of scales. Arms long and slender; Arm-spines, four or five near the disk, usually four along the middle and three toward the tip of the arms; they are subequal in length, the upper one a little longer and more enlarged toward the base, the tips obtuse and minutely roughened or spinulose on one side. Tentacle-scale absent or rudimentary. Mouth-shields small, rounded; side mouth-shields rather broad. Mouth-papillæ, four to each angle; a pair of large, stout, blunt ones stand at the end of the jaw, and a much smaller, spiniform, acute one a little farther back on each side; there is also an acute, spiniform, erect papilla outside of the mouth-tentacle, opposite the outer angle of the mouth-slits, as in *A. Otteri*. Ventral arm-plates, subquadrate, longer than broad, with the outer angles rounded and the inner ones truncated; farther out they become shorter and somewhat five-sided, with the outer margin rounded and the inner corners so much truncated as to form a median angle. Diameter of disk of an ordinary specimen, 5^{mm}; length of arms, about 30^{mm}. Resembles the young of *A. Otteri*, but differs in lacking tentacle-scales and in having the disk naked below, and in the arm-spines, which are not curved.

Amphiura macilenta Verrill. 1882.

B. range, 53 to 115 fathoms (70 fathoms, 1883). Very abundant locally, in moderate depths, as far south as off Cape Hatteras.

Amphiura Goësi (Ljung.) Lym.

B. range, 14 fathoms, station 2114, off Cape Hatteras.

Amphiura tenuispina (Ljung.) Lyman. Fig. 55.

B. range, 115 to 487 fathoms (407 fathoms, 1883). Not uncommon.

Amphilepis Norvegica (Ljung.) Lym.

B. range, 547 to 1,608 fathoms, 1882, 1883. Common and large.

Ophiocnida olivacea Lyman. 1869.

B. range, 63 to 192 fathoms (131 fathoms, 1883). Sometimes abundant locally.

Ophioscolex glacialis Müller & Troschel.

B. range, 101 to 1,000 fathoms, 1883. Common.

Ophioscolex quadrispinus Verrill. 1884. Figs. 56, 56*a*, 56*b*.

B. range, 101 to 234 fathoms (101 fathoms, off Nova Scotia, 1883). Rare.

Disk swollen; arms five, long, attenuated distally. The disk and base of arms are covered with a thick soft skin, with close wrinkles or small rounded verrucæ above, becoming concentric and radial wrinkles beneath, but beyond the basal part of the arms becoming smoother and thinner, concealing the feebly developed arm-plates. Arm-spines four, or alternately three and four, near base of arms (three in young examples), nearly equal, rather stout, tapered; lower ones blunt; upper, acute in part, scarcely as long as the breadth of the arm. Tentacle-scale small, tapering, acute; teeth, six to eight or more, rather slender, acute, often in pairs; mouth-papillæ, small, slender, acute, unequal, eight to ten on a side of each angle, besides two or three larger ones outside of the second mouth-tentacle and one within the slit at the first mouth-tentacle; the outer papillæ in large specimens are crowded so as to form two or more rows. Large examples have the disk 14^{mm} in diameter; length of arms, 70^{mm}. Stations 1121 and 2069; also Gulf of Maine, station 38, in 112 fathoms, 1878.

Hemieuryale tenuispina Verrill. 1885.

Astronyx? tenuispina Verrill, Amer. Journ. Sci., vol. 28, p. 219, 1884.

B. range, 1,362 to 2,033 fathoms, 1883. Locally abundant on *Scleroptilum gracile* V.

The disk is covered with thin roundish scales, visible when dried, without granules; radial shields prominent distally; arms with small scales above, and larger prominent ones along the sides; spines three, the upper longest; tentacle-scales small, spiniform; mouth-shield small, rhombic; mouth-papillæ several, small, in a regular row.

Astrochele Lymani Verrill. 1878. Fig. 53.

B. range, 264 to 1,608 fathoms; 407 to 1,608 fathoms, 1883. Abundant on *Acanella*.

Astronyx Loveni Müller and Troschel. Figs. 54, 54*a*, *b*.

B. range, 787 to 1,362 fathoms (843 to 1,362 fathoms, 1883). Common on Pennatulacea.

Gorgonocephalus Lamarckii Lyman.

Astrophyton Lamarckii M. & Tr., Syst. Ast., 1842.

B. range, 150 to 300 fathoms (194 fathoms, 1882; 239 fathoms, 1883). Common off Nova Scotia on Alcyonaria.

CRINOIDEA.

Antedon dentata (Say) Verrill. Fig. 58, young.

B. range, 69 to 640 fathoms (69 to 487 fathoms, 1883). Common; sometimes abundant locally.

LIST OF ECHINODERMATA DREDGED BY THE "FISH HAWK", 1880 TO 1882, NOT OBTAINED BY THE "ALBATROSS" IN 1883.

Toxodora ferruginea Verrill. 1882.
B. range, 100 to 155 fathoms, 1880, 1881. Locally common.

Spatangus purpureus Leske.
B. range, 89 to 158 fathoms, 1881, 1882. Not common.

Echinocyamus pusillus (Müller) Gray.
B. range, 146 fathoms, 1881. One specimen only.

Echinus Wallisi A. Agassiz.
B. range, 156 to 640 fathoms, 1880, 1881, 1882. Not common.

Temnechinus maculatus A. Agassiz.
B. range, 115 fathoms, 1880. One specimen only.

Dorocidaris papillata A. Agassiz (variety).
B. range, 104 to 158 fathoms, 1881, 1882. Locally common.

Hemipedina Cubensis A. Agassiz.
B. range, 194 fathoms, 1882. One specimen.

Poraniomorpha borealis Verrill. Figs. 46, 46*a*.
Asterina borealis Verrill, Amer. Journ. Sci., vol. xvi, p. 213, 1878.
B. range, 192 to 225 fathoms, 1880. Rare; northern.

Archaster Bairdii Verrill. 1882.
B. range, 351 to 396 fathoms, 1881. Rare.

Ctenodiscus crispatus Düben & Koren.
B. range, 182 to 321 fathoms, 1880, 1881, 1882. Local; abundant north of Cape Cod.

Ophioglypha (*Ophiopleura*) *aurantiaca* Verrill. 1882.
B. range, 86 to 317 fathoms, 1880, 1881, 1882. Rare.

Rhizocrinus Lofotensis Sars. Fig. 57, young.
B. range, 640 fathoms, 1882. Station 2226 in 2,021 fathoms, 1884.

ADDITIONAL DEEP-WATER ECHINODERMATA DREDGED BY THE "ALBATROSS" IN 1884.

Ankeroderma limicola Verrill. 1885.
Station 2171, in 444 fathoms, off Chesapeake Bay.

Aspidodiadema Antillarum A. Agassiz.
Station 2210, in 991 fathoms. Rare. West Indian.

Zoroaster fulgens W. Thomson.
Station 2206, in 1,043 fathoms. One example. European.

Pteraster pulvillus Sars.
Station 2226, off Chesapeake Bay, in 2,021 fathoms, 1884. Gulf of Maine and off Nova Scotia. Rare.

Astroporpa annulata Lütk. and Œrsted.

Off Cape Hatteras, stations 2267 to 2269, and 2301, in 48 to 68 fathoms, on *Titanideum suberosum* V. West Indian.

Bathycrinus, sp., near *B. gracilis* W. Thomson.

B. range, 2,021 fathoms, station 2226. One specimen.

LIST OF DECAPOD CRUSTACEA TAKEN BY THE "ALBATROSS" IN 1883.

The following list has been compiled from the papers published by Prof. S. I. Smith.* The Cumacea, Amphipoda, Isopoda, and lower groups, obtained in 1883, are not here included, for they have not yet been reported upon, though a few are mentioned on a previous page.

BRACHYURA.

Anamathia Agassizii Smith. 1885.

Amathia Agassizii Smith, 1882.

B. range, 142 to 333 fathoms (142 to 197 fathoms, 1883).

Hyas coarctatus Leach.

B. range, 35 to 906 fathoms, 1883. Chiefly northern.

Collodes robustus Smith. 1883.

B. range, 56 to 373 fathoms (78 to 373 fathoms, 1883).

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* The following papers by Professor Smith are the principal ones relating to the deep-water Crustacea of this region:

Preliminary Notice of the Crustacea dredged in 64 to 325 fathoms, off the south coast of New England by the United States Fish Commission in 1880. From the Proceedings of the National Museum, Washington, vol. iii, for 1880, January, 1881.

Preliminary Report on the Brachyura and Anomura dredged in deep water off the south coast of New England by the United States Fish Commission in 1880, 1881, and 1882. From the same, vol. vi, p. 1, June, 1883.

Report on the Crustacea. Part I. Decapoda ["Blake" expedition]. From the Bulletin Mus. Comp. Zoology, x, 1882.

Report on the Decapod Crustacea of the "Albatross" dredgings off the east coast of the United States in 1883. Extracted from the annual report of the Commissioner of Fish and Fisheries for 1882. Published 1884.

Crustacea of the "Albatross" dredgings in 1883. From the American Journal of Science, vol. xxviii, July, 1884.

On some new or little known Decapod Crustaceas from recent Fish Commission dredgings, off the east coast of the United States. From the Proceedings of the National Museum, vii, p. 493, 1885.

The following papers contain descriptions of the deep-water Isopoda:

Report on the Isopoda ["Blake" expedition]. From the Bulletin of the Museum of Comparative Zoology, vol. xi, No. 4, September, 1883. By Oscar Harger.

Report on the Marine Isopoda of New England and adjacent waters. This report, part vi, for 1878, p. 297. By Oscar Harger.

The following paper, relating to the "Blake" Crustacea, contains descriptions of species also dredged by the United States Fish Commission:

Études préliminaires sur les Crustacés. From the Bulletin of the Museum of Comparative Zoology, vol. viii, No. 1, December, 1880. By A. Milne-Edwards.

Euprognatha rastellifera Stimpson.

B. range 44 to 229 fathoms (66 to 98 fathoms, 1883). Very abundant locally, 1880, 1881.

Cancer irroratus Say.

B. range, shore to 314 fathoms (18 to 86 fathoms, 1883). Extends to the region south of Cape Hatteras in moderate depth.

Cancer borealis Stimpson.

B. range, shore to 435 fathoms (18 to 373 fathoms, 1883). Found as far south as Cape Hatteras, off the coast.

Geryon quinquedens Smith. 1879. Fig. 156.

B. range, 105 to 740 fathoms (105 to 588 fathoms, 1883); 263 to 740 fathoms, "Blake" expedition.

Achelous Gibbesii Stimpson.

B. range, 16 fathoms, 1883; off Cape Hatteras.

Persephone punctata (Brown) Stimpson.

B. range, 14 fathoms, 1883; off Cape Hatteras.

Ethusina abyssicola Smith. 1884.

B. range, 1,497 to 1,735 fathoms, 1883.

ANOMURA.

Latreillia elegans Roux.

B. range, 70 to 134 fathoms (70 fathoms, 1883).

Homola barbata (Fabricius) White.

B. range, 56 to 373 fathoms (143 to 373 fathoms, 1883).

Porcellana Sayana (Leach) White.

B. range, 48 fathoms, 1883; off Cape Hatteras.

Lithodes maia Leach.

B. range, 141 to 291 fathoms (141 fathoms, 1883; off Nova Scotia).

Lithodes Agassizii Smith. 1882. Figs. 151, 151*a*, 151*b*.

B. range, 410 to 1,255 fathoms (843 to 1,255 fathoms, 1883).

Eupagurus bernhardus (Linné) Brandt.

B. range, 5 to 86 fathoms, 1883.

Eupagurus politus Smith. 1882.

B. range, 31 to 640 fathoms, 1883.

Eupagurus pubescens (Kröyer) Brandt.

B. range, 26 to 86 fathoms (31 to 86 fathoms, 1883).

Eupagurus Kröyeri Stimpson.

B. range, 35 to 640 fathoms (35 to 239 fathoms, 1883).

Eupagurus longicarpus (Say) Stimpson.

B. range, shore to 20 fathoms (19 fathoms, 1883).

Eupagurus pollicaris (Say) Stimpson.

B. range, 1 to 20 fathoms (18 to 19 fathoms, 1883).

Catapagurus Sharreri A. M. Edwards. Fig. 26.
Hemipagurus socialis Smith. 1881.
B. range, 51 to 264 fathoms (78 to 140 fathoms, 1883).

Parapagurus pilosimanus Smith. 1879. Fig. 28.
B. range, 250 to 2,221 fathoms (1,731 to 2,221 fathoms, 1883).

Sympagurus pictus Smith. 1883. Fig. 161.
B. range, 164 to 264 fathoms (168 fathoms, 1883).

Munida Caribæa Smith. 1882. (Stimpson ?) Fig. 153.
B. range, 56 to 264 fathoms (69 to 131 fathoms, 1883). Very abundant locally in 1880, 1881.

Munidopsis rostrata Smith. 1885.
Galacantha rostrata A. M.-Edwards.
B. range, 1,098 to 1,342 fathoms, 1883; 1,241 to 1,394 fathoms, "Blake" expedition.

Munidopsis Bairdii Smith. 1885.
Galacantha Bairdii Smith. 1884.
B. range, 1,497 fathoms, 1883.

Munidopsis curvirostra Whiteaves.
B. range, 75 to 1,290 fathoms. 1883.

MACRURA.

Pentacheles sculptus Smith. 1880. Fig. 152.
B. range, 464 to 843 fathoms (843 fathoms, 1883).

Pentacheles nanus Smith. 1884.
B. range, 843 to 1,917 fathoms, 1883.

Pentacheles debilis Smith. 1884.
B. range, 1,290 to 1,309 fathoms, 1883.

Ceraphilus Agassizii Smith. 1882. Fig. 155.
B. range, 499 to 959 fathoms, 1883; 263 to 603 fathoms, "Blake" expedition.

Crangon vulgaris Fabricius.
B. range, shore to 20 fathoms (18 to 19 fathoms, 1883).

Pontophilus Norvegicus M. Sars.
B. range, 105 to 524 fathoms (105 to 239 fathoms, 1883).

Pontophilus brevirostris Smith. 1881.
B. range, 51 to 233 fathoms (65 to 98 fathoms, 1883).

Pontophilus abyssi Smith. 1884.
B. range, 1,917 to 2,221 fathoms, 1883.

Sabinea princeps Smith. 1882. Fig. 157.
B. range, 372 to 888 fathoms (640 to 888 fathoms, 1883).

Sabinea Sarsii Smith. 1879.
B. range, 122 to 150 fathoms, 1883; off Nova Scotia.

Glyphocrangon sculptus Smith. 1884. Fig. 154.

Rhachocaris sculpta Smith, "Blake" expedition, Crust., p. 49, pl. 5, fig. 3, pl. 6, fig. 3–3d, 1882.

B. range, 1,098 to 1,395 fathoms, 1883.

Hippolyte Liljeborgii Danielssen.

B. range, 75 to 524 fathoms (75 to 150 fathoms, 1883).

Hippolyte pusiola Kröyer.

B. range, 49 fathoms, 1883; off Nova Scotia.

Hippolyte polaris Ross.

B. range, 122 fathoms, 1883; off Nova Scotia.

Hippolyte Grœnlandica (Fabricius) Miers.

B. range, 35 fathoms, 1883; George's Bank.

Bythocaris gracilis Smith. 1885.

B. range, 888 to 1,043 fathoms, 1883, 1884.

Pandalus Montagui Leach.

B. range, 113 fathoms, 1883; off Nova Scotia.

Pandalus propinquus G. O. Sars.

B. range, 122 to 524 fathoms (122 to 239 fathoms, 1883).

Pandalus borealis Kröyer.

B. range, 105 fathoms, 1883; off George's Bank.

Pandalus leptocerus Smith. 1881.

B. range, 10 to 430 fathoms (18 to 197 fathoms, 1883).

Nematocarcinus ensiferus Smith. 1884.

Eumiersia ensifera Smith, "Blake" expedition, Crust., p. 77, pl. 13, figs. 1–9, 1882.

B. range, 588 to 2,033 fathoms, 1883.

Ephyrina Benedicti Smith. 1885.

B. range, 959 fathoms, 1883.

Acanthephyra Agassizii Smith. 1882.

Miersia Agassizii Smith, 1882.

B. range, 105 to 2,949 fathoms, 1883.

Acanthephyra eximea Smith. 1884.

B. range, 938 fathoms, 1883; off Cape Hatteras.

Acanthephyra brevirostris Smith. 1885.

B. range, 1,395 to 2,949 fathoms, 1883.

Notostomus robustus Smith. 1884. Fig. 160.

B. range, 1,309 to 1,555 fathoms, 1883.

Meningodora mollis Smith. 1882.

B. range, 1,106 fathoms, 1883; 1,632 fathoms, "Blake" expedition.

Hymenodora glacialis G. O. Sars.

B. range, 861 to 2,949 fathoms, 1883, 1884.

Pasiphaë princeps Smith. 1884. Fig. 158.

B. range, 1,342 fathoms, 1883.

Parapasiphaë sulcatifrons Smith. 1884. Fig. 162.
B. range, 516 to 2,949 fathoms, 1883.

Parapasiphaë cristata Smith. 1884.
B. range, 1,628 fathoms, 1883.

Parapasiphaë compta Smith. 1884.
B. range, 2,369 fathoms, 1883.

Benthœcetes Bartletti Smith. 1882.
Benthesicymus Bartletti Smith, "Blake" expedition, Crust., p. 82, pl. 14, figs. 1–7, 1882.
B. range, 588 to 858 fathoms, 1883.

Benthesicymus? carinatus Smith. 1884.
B. range, 1,022 fathoms, 1883.

Benthesicymus?, sp. indet.
B. range, 1,555 fathoms, 1883.

Amalopenæus elegans Smith. 1882.
B. range, 372 to 2,369 fathoms (640 to 2,369 fathoms, 1883); 457 to 1,632 fathoms, "Blake" expedition.

Amalopenæus valens Smith. 1884.
B. range, 640 fathoms, 1883.

Aristeus? tridens Smith. 1884. Fig. 159.
B. range, 843 to 2,221 fathoms, 1883.

Hepomadus tener Smith. 1884.
B. range, 2,949 fathoms, 1883.

Hymenopenæus microps Smith. 1884.
B. range, 906 to 1,731 fathoms, 1883.

Sergestes arcticus Kröyer.
B. range, 139 to 1,025 fathoms (221 to 1,025 fathoms, 1883).

Sergestes robustus Smith. 1881.
B. range, 372 to 1,632 fathoms (640 to 641 fathoms, 1883); 1,632 fathoms, "Blake" expedition.

Sergestes mollis Smith. 1882.
B. range, 373 to 2,949 fathoms, 1883; 1,632 fathoms, "Blake" expedition.

SCHIZOPODA.

Gnathophausia, sp.
B. range, 858 to 2,033 fathoms, 1883.

Gnathophausia, sp.
B. range, 959 to 2,949 fathoms, 1883.

Thysanoessa, sp.
B. range, 398 to 1,067 fathoms.

Lophogaster, sp.
B. range, 1,022 to 2,949 fathoms, 1883.

Thysanopoda Norvegica Kröyer.

B. range, 35 to 252 fathoms (?); found in trawl-wings from various depths; 150 to 239 fathoms, 1883. Common at the surface, northward.

Boreomysis tridens G. O. Sars.

B. range, 351 to 500 fathoms, 1880, 1882, 1883. Common in the trawl-wings.

LIST OF ADDITIONAL DEEP-WATER CRUSTACEA DREDGED BY THE "FISH HAWK" AND "BLAKE," 1880–'82.

The following species, previously dredged in this region, have not yet been recorded as taken in 1883, but many of the Amphipods and Isopods, as well as additional species, are known to be among the collections of 1883, not yet carefully examined.

BRACHYURA.

Anamathia Tanneri Smith. 1885.

Amathia Tanneri Smith, Proc. Nat. Mus., vi, p. 3, 1883.

B. range, 130 to 146 fathoms, 1881.

Lispognathus furcatus A. M.-Edwards.

B. range, 317 to 225 fathoms, 1881, 1882.

Lambrus Verrillii Smith. 1881.

B. range, 65 to 134 fathoms, 1880, 1881.

Bathynectes longispina Stimpson.

B. range, 85 to 225 fathoms, 1881, 1882.

Acanthocarpus Alexandri Stimpson.

B. range, 50 to 200 fathoms, 1880, 1881. Common in 1880.

Myropsis quinquespinosa Stimpson.

B. range, 79 fathoms, 1881. One specimen.

Cymopolia gracilis Smith. 1883.

B. range, 142 fathoms, 1880. One specimen.

Ethusa microphthalma Smith. 1881.

B. range, 67 to 156 fathoms, 1880, 1881.

ANOMURA.

Lyreidus Bairdii Smith. 1881.

B. range, 100 to 120 fathoms, 1880. Two specimens.

Porcellana Sigsbeiana A. M.-Edwards.

B. range, 134 fathoms, 1881. One specimen.

Catapagurus gracilis Smith. 1882.

Hemipagurus gracilis Smith, Proc. Nat. Mus., iii, p. 426, 1881.

B. range, 53 to 155 fathoms. Common in 1880 and 1881.

Munida valida Smith. 1883.
B. range, 245 to 640 fathoms, 1882. Two specimens.

Eumunida picta Smith. 1883.
B. range, 115 to 158 fathoms, 1881, 1882.

Anoplonotus politus Smith. 1883.
B. range, 79 to 134 fathoms, 1880, 1881.

MACRURA.

Arctus depressus Smith. 1881.
B. range, 86 fathoms, 1880. Rare.

Nephropsis aculeatus Smith. 1881.
B. range, 100 to 126 fathoms, 1880. Rare.

Axius armatus Smith. 1881.
B. range, 100 to 142 fathoms, 1880. Rare.

Hippolyte Phippsii Kröyer.
B. range, 73 fathoms, near George's Bank, "Blake" expedition. Not uncommon northward in shallow water.

Caridion Gordoni Goës.
B. range, 143 fathoms, "Blake" expedition. Northern.

Bythocaris nana Smith, 1885.
B. range, 65 to 142 fathoms, 1880; 178 fathoms, "Blake" expedition, 1880.

Pandalus tenuipes Smith. 1881.
B. range, 100 to 252 fathoms, 1880.

Penæus politus Smith. 1881.
B. range, 142 fathoms, 1880. One specimen.

SCHIZOPODA.

Pseudomma roseum G. O. Sars.
B. range, 500 fathoms, 1880.

Lophogaster, sp.
B. range, 155 fathoms, 1880.

CUMACEA.

Diastylis quadrispinosus G. O. Sars.
B. range, 100 to 142 fathoms, 1880. Additional species have also been taken.

STOMATOPODA.

Lysiosquilla armata Smith. 1881.
B. range, 65 to 120 fathoms, 1880, 1882.

AMPHIPODA.

The following list is very incomplete. Many additional species have been taken which have not yet been reported upon:

Stegocephalus ampulla Bell.
B. range, 168 to 264 fathoms, 1880, 1881, 1882.

Epimeria loricata G. O. Sars.
B. range, 90 to 640 fathoms, 1880, 1881, 1882.

Haploops setosa Boeck.
B. range, 252 fathoms, 1880.

Ptilocheirus pinguis Stimpson.
B. range, 45 to 86 fathoms, 1880, 1881.

Erichthonius difformis M.-Edw.
B. range, 192 fathoms, 1880, 1881.

Unciola irrorata Say.
B. range, 1 to 192 fathoms, 1880, 1881, 1882, 1883.

Themisto bispinosa Boeck.
B. range, 44 to 110 fathoms. Perhaps also from the surface.

Neohela phasma Smith. 1881.
B. range, 349 to 374 fathoms, 1880, 1882.

Caprella, sp.
B. range, 843 to 1,080 fathoms, 1883, 1884.

ISOPODA.

The following list is very incomplete, for the Isopods collected since 1881 have been but little examined.

Many of the following were also taken in 1883. Several species described by Mr. Harger from the "Blake" expedition, dredged south of Cape Hatteras, are not included in this list.

Janira alta (Stimp.) Harger.
B. range, 65 to 487 fathoms, 1880, 1882.

Munnopsis typica Sars.
B. range, 125 to 142 fathoms, 1880, 1881.

Astacilla granulata (Sars) Harger. Fig. 166.
B. range, 291 to 640 fathoms, 1882.

Cirolana polita Harger.
B. range, 89 to 321 fathoms, 1880, 1882.

Cirolana impressa Harger. 1883. Fig. 165.
B. range, 100 to 321 fathoms, 1880, 1881.

Æga psora (L.) Kröyer.
B. range, 306 to 640 fathoms, 1880, 1882.

Rocinela Americana (Sch. & Mein.)
B. range, 85 to 157 fathoms, 1880, 1882; 257 fathoms, "Blake" expedition.

Rocinela, sp.
B. range, 129 fathoms, "Blake" expedition.

Syscenus infelix Harger. Fig. 164.
B. range, 182 to 640 fathoms, 1880, 1881, 1882.

Phryxus abdominalis Köyer.
B. range, 97 to 351 fathoms, on *Pandalus leptocerus*.

Anthura, sp.
B. range, 349 fathoms, 1882.

Gnathia cerina (Stimp.) Harger.
B. range, 65 to 487 fathoms, 1880.

Tanais, sp.
B. range, station 1146, 1881.

LIST OF DEEP-WATER PYCNOGONIDA.

The following list includes the Pycnogonids that have been recorded from the region under discussion, obtained by the "Blake"* and "Fish Hawk." It is very incomplete, for those collected in 1881, 1882, and 1883 have not been fully studied, although many interesting species were obtained. Several of the following species recorded as having been obtained in 1883 and 1884 were identified by Prof. S. I. Smith. Others, not here recorded, are known to have been taken in 1883.

Pycnogonum littorale Ström.
B. range, 73 to 810 fathoms. Common northward from low-water mark to 100 fathoms.

Colossendeis angusta Sars.
B. range, 810 to 1,242 fathoms, "Blake."

Colossendeis colossea Wilson. Fig. 169.
B. range, 500 to 1,500 fathoms; 499 to 1,106 fathoms, 1883; 924 to 1,230 fathoms, 1884.

Colossendeis macerrima Wilson. Fig. 170.
B. range, 317 to 1,073 fathoms; 922 fathoms, "Blake" expedition; 317 fathoms, 1882; 1,073 fathoms, 1884.

Colossendeis gracilis Hoeck.
B. range, 924 to 1,600 fathoms, 1884. (Identified by S. I. Smith.)

Scæorhynchus armatus Wilson. Figs. 171, 171*a*.
B. range, 1,242 fathoms, "Blake" expedition; 1,073 fathoms, 1884.

* For the "Blake" collection, see report on the Pycnogonida, by E. B. Wilson, Bulletin Mus. Comp. Zoology, viii, No. 12, five plates, 1881.

Pallenopsis longirostris Wilson.
B. range, 500 fathoms, 1880

Nymphon grossipes (L.) Fabr.
B. range, 150 to 524 fathoms. Common northward in 12 to 110 fathoms.

Nymphon Strömii Kröyer.
B. range, 234 to 780 fathoms; 260 to 524 fathoms, "Blake;" 234 to 780 fathoms, 1882.

Nymphon pallenoides Sars.
B. range, 922 fathoms, "Blake" expedition.

LIST OF DEEP-SEA AND SURFACE MOLLUSCA COLLECTED BY THE "ALBATROSS" IN 1883.

In the following list the shallow-water Mollusca dredged off Nova Scotia and Cape Hatteras are not included,* but the pelagic species belonging to the Pteropoda and Heteropoda, &c., are introduced, partly as a matter of convenience and partly because their dead shells are constantly dredged up from the bottom at all depths.

In addition to the following list of Mollusca, a large number of species were dredged in the same region by the "Fish Hawk" in 1880 to 1882, which are here omitted. They have been already enumerated by Miss K. J. Bush, in her list of the Mollusca of the "Fish Hawk" dredgings (this report, vol. xi, p. 701) and in my Second Catalogue of Mollusca. About forty species not contained in either of the lists were dredged in the same region by the "Albatross" in 1884. Of these about twenty-five were undescribed.

The nomenclature of this list is, with the exception of a few necessary changes, essentially the same as that used in my " Second Catalogue of of Mollusca," in the Transactions of the Connecticut Academy, vol. vi, 1884, where the synonymy is briefly given. The references in the following list are to that paper and the preceding one, in volume v of the Transactions. A large part of the new forms were described and figured in those two papers.†

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* For the Hatteras shells, see special list by Miss K. J. Bush, p. 77.

† Catalogue of Marine Mollusca added to the Fauna of New England during the past ten years, from the Transactions of the Connecticut Academy, vol. v., Part II, 1882. Five plates.

Second Catalogue of Mollusca, recently added to the Fauna of the New England coast and the adjacent parts of the Atlantic, consisting mostly of deep-sea species, with notes on others previously recorded. From the Transactions of the Connecticut Academy, vol. vi, Part I, 1884. Five plates.

Third Catalogue of Mollusca. From the same, vol. vi, Part II, 1885. Three plates.

Descriptions and lists of many of these Mollusca are also contained in the following papers, by the writer:

Notice of recent additions to the marine Invertebrata of the northeastern coast of

As it is always important, in giving the bathymetrical distribution of shells to distinguish between those taken alive and those of which only dead shells are obtained (which may have been carried by fishes, crabs, and various other agencies far from their true habitats), an asterisk (*) is added to designate living specimens, while a dagger (†) indicates dead shells. When no sign is added, it is to be understood that the specimens were living. The "Bathymetrical range" here refers only to the range as actually observed in this region by the United States Fish Commission, unless otherwise stated.

The geographical distribution is indicated, in a general way, by the abbreviations following the range in depth, but I have not attempted to make it complete in this respect. Owing to the uncertainty as to the alleged identity of the species recorded from other regions with our own, and to the incompleteness of the published lists of species collected by the various other recent dredging expeditions, the knowledge of the foreign distribution of many of these species is still very imperfect, and is sure to be largely increased within a few years, so that any facts of this kind that can now be given will have, at best, only a temporary value. The abbreviations are as follows: N., = northern, indicates that the species ranges northward along the American coast, beyond New England waters; S., = southern, southward beyond Cape Hatteras; Arc., = Arctic; Eu., = European; Med., = Mediterranean; Af., = West African; P., = North Pacific; As., = North Asia; Cb., = Caribbean Sea and West Indies; Oc., = Oceanic or pelagic.

America, with descriptions of new genera and species and critical remarks on others. Proceedings of the United States National Museum, vol. iii, December, 1880, and January, 1881.

Part II, Mollusca, with notes on Annelida, Echinodermata, &c., collected by the United States Fish Commission [pp. 356–405], December, 1880, and January, 1881.

Part III, Catalogue of Mollusca, recently added to the Fauna of Southern New England [pp. 405–409], by A. E. Verrill.

Part IV, in vol. v [pp. 315 to 343], 1882, Additions to the deep-water Mollusca, taken off Martha's Vineyard, in 1880 and 1881.

The Cephalopods of the northeastern coast of America. Part II, The smaller Cephalopods, including the "Squids" and Octopi, with other allied forms. Trans. Conn. Acad., v [pp. 259–424, pls. 26–56], June, 1880, to October, 1881.

Report on the Cephalopods [of the "Blake" expedition, 1880], and on some additional species dredged by the United States Fish Commission steamer "Fish Hawk," during the season of 1880. Bulletin Mus. Comp. Zool., vol. viii [pp. 99–116, 8 plates], March, 1881.

Supplement report on the "Blake" Cephalopods, vol. xi, pp. 105-115, plates i, ii, iii, 1883.

Report on the Cephalopods of the northeastern coast of America. This report, Part VII, for 1879 [244 pages, 46 plates], 1882.

See also Brief Contributions to Zoology, Nos. 40 to 56, in American Journal of Science, 1877 to 1884.

CEPHALOPODA.

Lestoteuthis Fabricii (Licht.) Verrill. Trans. Conn. Acad., v, 291, 390, pl. 45, f. 1–2*d*; pl. 46, f. 1–1*f*; pl. 55, f. 1–1*d*.
Bathymetrical range, 255 to 906 fathoms. N., Arc., P.

Ommastrephes illecebrosus (Les.) V. v, 268, pls. 28, 29, 37, 38, 39.
B. range, 0 to 1,022 f.; beaks 1,091 to 1,917 f. N.

Sthenoteuthis Bartramii V. v, 288.
Surface.* Southern. Oc.

Mastigoteuthis Agassizii V. v, 297, pl. 48; pl. 49, f. 2, 3–3*g*; vi, 243.
B. range, 640 to 1,050 f.

Cheiroteuthis lacertosa V. v, 299, 408, pl. 47, f. 1–1*b*; pl. 56, f. 1–1*f*; vi, 243.
B. range, 435 to 2,221 f. (2,949, arms). N.

Leptoteuthis diaphana V. vi, 141, pl. 32, f. 1. Fig. 62.
B. range, 1,731 f.

Brachioteuthis Beanii V. v, 406, pl. 55, f. 3–3*b*; pl. 56, f. 2–2*a*; vi, 245.
B. range, 183 to 843 f.

Calliteuthis reversa V. v, 295, pl. 46, f. 1–1*b*; vi, 243.
B. range, 365 to 2,369 f.

Desmoteuthis hyperborea (Steenst.) V. v, 302, pl. 27, f. 1–2; pl. 39, f. 1.
B. range, 641 f., off Chesapeake Bay. N., Arc.

Desmoteuthis tenera V. v, 412, pl. 55, f. 2–2*d*; pl. 56, f. 3; vi, 245.
B. range, 396 to 1,346 f.

Rossia sublevis V. v, 354, 419, pl. 30, f. 2; pl. 31, f. 3; pl. 46, f. 4; pl. 47, f. 2–4.
B. range, 115 to 640 f. N.

Heteroteuthis tenera V. v, 357, 419, pl. 46, f. 2–2*d*, 3–3*b*; pl. 47, f. 5–5*b*.
B. range, 18 to 301 f., eggs 317 f.

Argonauta argo Linné. v, 364, 420; vi, 247, pl. 28, f. 1–1*b*. Figs. 63, 63*a*, 63*b*.
B. range, shells, 64 to 1,917 f.; living at surface. Oc., Cb., S., Med.

Alloposus mollis V. v, 366, 420, pl. 50, f. 1–2*a*; pl. 51, f. 4; vi, 247.
B. range, 238 to 1,346 f.; frag. 1,735 f.

Octopus Bairdii V. v, 368, 421, pl. 33, f. 1, 1*a*; pl. 34, f. 5, 6; pl. 36, f. 10; pl. 38, f. 8; pl. 49, f. 4, 4*a*; pl. 51, f. 1, 1*a*.
B. range, 85 to 843 f.; 28 to 300 f. N. of Cape Cod. N., Eur.

Octopus piscatorum V. v, 377, pl. 36, f. 1, 2; vi, 248.
B. range, 1,362 f. Northern.

Octopus Carolinensis V. vi, 235.
B. range, 142 f., off Cape Hatteras.

Octopus gracilis V. vi, 236.
B. range, 1290 f.

Eledone verrucosa V. v, 380, pls. 52, 53; vi, 248.
B. range, 787 to 1,255 f.

Eledonella pygmæa V. vi, 145, pl. 32, f. 2. Fig. 64.
B. range, 2,949 f., off Chesapeake Bay.

Stauroteuthis syrtensis V. (?) v, 382, pl. 32, f. 1–5; vi, 249.
B. range, 1,346 f., station 2034, off Nova Scotia. N.

GASTROPODA.

TOXOGLOSSA.

Admete Couthouyi Jay (=*A. viridula* Gld.)
B. range, 155 to 1,255 f. N., Arc., Eu.

Pleurotoma Dalli V. and S. v, 451, pl. 57, f. 1–1*a*. Figs. 66, 66*a*.
B. range, 94 to 142 f.*; 146 f.†

Pleurotomella Agassizii V. and S. v, 454, pl. 57, f. 3, 3*a*. Fig. 67.
B. range, 39 to 1,309 f.*; 1,608 f.†

Pleurotomella Bairdii V. and S. vi, 147, pl. 31, f. 1. Fig. 68.
B. range, 1,608 to 1,731 f.*; 2,221 f.†

Pleurotomella Benedicti V. and S. vi, 148, pl. 31, f. 2, 2*a*. Fig. 70.
B. range, 1,290 f.

Pleurotomella Sandersoni V. vi, 149, pl. 31, f. 3, 3*a*. Fig. 71.
B. range, 1,290 to 2,033 f.

Pleurotomella Saffordi V. and S. vi, 151, pl. 31, f. 4, 4*a*. Fig. 72.
B. range, 843 to 1,608 f.

Pleurotomella bandella Dall=*P. Diomedeæ* V. vi, 152, 250, pl. 31, f. 5–5*a*. Fig. 73.
B. range, 1,290 to 2,033 f. Cb.

Pleurotomella Emertoni V. and S. vi, 154, pl. 31, f. 6. Fig. 74.
B. range, 1,917 f.† Off Chesapeake Bay. Cb.

Pleurotomella Bruneri V. and S. vi, 155, pl. 31, f. 7, 7*a*. Fig. 75.
B. range, 1,608 f.*; 2,033 f.†

Pleurotomella Catharinæ V. and S. vi, 155, pl. 31, f. 9, 9*a*. Figs. 76, 76*a*.
B. range, 843 to 2,033 f.

Gymnobela engonia V. vi, 157.
B. range, 906 to 1,451 f.†; 1,608 f.*

Gymnobela curta V. vi, 158, pl. 31, f. 10.
B. range, 843 to 1,290 f.*; 1,467 to 1,917 f.†

Gymnobela curta, var. *subangulata* V. vi, 159.
B. range, 197 to 2,033 f.†; 1,290 to 1,451 f.*

Gymnobela brevis Verrill. 1885.
B. range, 1,290 to 1,608 f.

Gymnobela hebes V. v, 459, pl. 57, f. 7.
B. range, 252 to 906 f.*; 1,290 to 2,033 f.†

Bela ovalis Friele=*Bela pygmæa* V. v, 460, pl. 57, f. 8.
B. range, 312 to 906 f.*; 1,091 f.† N., Eu., Arc.

Bela tenuicostata Sars.
B. range, 843 to 1,290 f. Eu.

Bela cancellata (Mighels) Stimpson. v, 475, pl. 43, f. 10, 11; pl. 57, f. 13.
B. range, 126 to 547 f.† N., Arc., Eu.

Bela subvitrea V. vi, 160.
B. range, 843 f. Off Cape Hatteras.

Bela subturgida V. vi, 161.
B. range, 843 f. Off Cape Hatteras.

Bela Rathbuni V. vi, 236.
B. range, 1,395 f.† Off Cape Hatteras.

Spirotropis ephamilla V. vi, 162.
B. range, 1,917 f.†; 2,221 f.* Off Chesapeake Bay.

Typhlomangilia Tanneri V. and S. vi, 163, pl. 31, f. 8. Fig. 78.
B. range, 1,290 f.

Taranis Mörchii (Malm) Jeffreys. v. 486, pl. 57, f. 18.
B. range, 365 f.†; 368 to 858 f.* N., Arc., Eu., Cb.

Taranis Mörchii, var. *tornatus* V. vi, 251.
B. range, 1,255 f. Off Nova Scotia.

Taranis pulchella V. v, 487, pl. 57, f. 17; vi, pl. 29, f. 8. Fig. 77.
B. range, 349 to 487 f.

Admete inflata Friele=*Trichotropis inflata* Friele. vi. 178.
B. range, 1,290 f. Arc.

RACHIGLOSSA.

Marginella borealis V. vi, 165, pl. 29, f. 4. Fig. 79.
B. range, 64 to 100 f.†; 66½ to 81 f.*

Volutella lachrimula Gld. vi, 166.
B. range, 142 f.*; 516 f.† Off Cape Hatteras. S.

Buccinum undatum Linné. v, pl. 58, f. 10.
B. range, 6 to 123 f.*; 142½ to 843 f.† N., Arc., Eu.

Buccinum cyaneum Brug. v, 492, pl. 43, f. 5; pl. 58, f. 11.
B. range, 101 to 150 f., off Cape Cod. N., Arc., Eu.

Buccinum abyssorum V. and S. vi, 167, pl. 31, f. 11–11*b*. Figs. 80, *a*.
B. range, 49 f.†; 906 to 1,309 f.*

Sipho Stimpsonii Mörch. v, 499, pl. 57, f. 24.
B. range, 16 to 300 f. N.

Sipho Stimpsonii, var. *liratulus* V. v, 500.
B. range, 18 f.†; 55 to 319 f.* N.

Sipho pubescens V. v, 501, pl. 43, f. 6; pl. 57, f. 25.
B. range, 18 to 179 f.†; 192 to 640 f.* N.

Sipho pygmæus (Gld.) V. v, 501, pl. 57, f. 21.
B. range, 12 to 640 f. N.

Sipho parvus V. and S. v, 504, pl. 57, f. 20–20*b*.
B. range, 193 to 906 f.

Sipho obesus V. vi, 168.
B. range, 843 f. Off Cape Hatteras.

Sipho profundicola V. and S. vi, 170, pl. 31, f. 13. Fig. 81.
B. range, 1,497 to 1,917 f.†; 2,033 f.*

Sipho profundicola, var. *dispar* V. vi, 171.
B. range, 1,555 f.

Sipho glyptus V. v, 505, pl. 57, f. 22; pl. 58, f. 1, 1*a*. Fig. 82.
B. range, 193 to 547 f.

Sipho cælatus V. v, 506, pl. 57, f. 19, 19*a*.
B. range, 75 to 616 f.†; 302 to 516 f.*

Sipho cælatus, var. *hebes* V. vi, 172.
B. range, 640 to 1,255 f.

Sipho (Mohnia) *cælatulus* V. vi, 172.
B. range, 516 to 547 f.†; 906 to 1,290 f.*

Sipho (Mohnia) *simplex* V. vi, 174.
B. range, 99½ f.†; 843 f.*

Sipho (?) *hispidulus* V. vi, 239.
B. range, 2,033 f.* Off Delaware Bay.

Neptunea despecta (Linné) Ad., var. *tornata* (Gld.).
B. range, 69 to 100 f.† off George's Bank. N., Arc., Eu.

Neptunea decemcostata (Say) H. and A. Ad.
B. range, 6 to 322 f.†; 41 to 86 f.* N.

Trophon clavatus Sars. (?) vi, 176.
B. range, 843 to 2,033 f. Eu. (?)

Urosalpinx Carolinensis V. vi, 237.
B. range, 142 to 516 f.†; 938 f.* Off Cape Hatteras.

Urosalpinx macra V. vi, 239.
B. range, 142 f.†

Anachis Haliæeti (Jeff.). v, 513, pl. 43, f. 7; vi, 252.
B. range, 79 f.†; 115 to 640 f.* N., Arc., Eu.

Astyris diaphana V. v, 513, pl. 58, f. 2.
B. range, 64 f.†; 100 to 487 f.*

Astyris pura V. v, 515.
B. range, 71 f.†; 100 to 1,255 f.*

TÆNIOGLOSSA.

Dolium Bairdii V. and S. v, 515; vi, 253, pl. 29, f. 2–2*b*. Figs. 83, 83*a*.
B. range, 89 to 234 f.†; 98 to 202 f.*

Benthodolium abyssorum V. and S. vi, 177, pl. 31, f. 12–12*b*. Figs. 84, 84*a*.
B. range, 1,395 f.†; 2,221 f.* Off Chesapeake Bay.

Natica clausa Brod. and Sowerby.
B. range, 13 to 1,255 f.†; 238 to 843 f.* N., Arc., Eu.

Lunatia heros (Say) H. and A. Adams.
B. range, 0 to 238 f. N., S.

Lunatia Grönlandica (Möll.) Ad.
B. range, 12 to 65 f.†; 75 to 1,290 f.* N., Arc., Eu.

Lamellaria pellucida, var. *Gouldii* V. v, 518, pl. 58, f. 3.
B. range, 44 to 1,497 f.

Piliscus commodus (Midd.). vi, 191.
B. range, 150 f., off Nova Scotia. Arc., Eu., P.

Capulus Hungaricus (Linné). v, 519; vi, pl. 29, f. 6.
B. range, 71* to 458 f. Eu.

Crucibulum striatum (Say) H. and A. Adams.
B. range, 3 to 65 f.*; 100 f.† N.

Crepidula plana Say.
B. range, 0 to 55 f.*; 155 to 487 f.† N., S.

Velutina lævigata (L.) Gld.
B. range, 15 to 86 f.*; 100 to 130 f.† N., Arc., Eu.

Torellia fimbriata V. and S. v, 520, pl. 57, f. 27, 27*a*. Fig. 85.
B. range, 142 to 321 f.

Torellia vestita Jeff. v, 521, pl. 42, f. 5.
B. range, 4 to 86 f.†; 146 to 317 f.* N., Eu.

Litiopa bombyx Rang. v, 523.
Surface.* S., O.

Cingula Jan-Mayeni (Friele) V. v, 524, pl. 42, f. 8. Fig. 86.
B. range, 238 to 1,290 f. N., Arc.

Cingula brychia V. vi, 179, pl. 32, f. 9.
B. range, 349 to 1,290 f.

Cingula syngenes V. vi, 180, pl. 32, f. 11.
B. range, 142 f.† Off Cape Hatteras.

Cingula leptalea V. vi, 182, pl. 32, f. 10.
B. range, 858 f. Off Nova Scotia.

Cingula apicina V. vi, 183, pl. 32, f. 8.
B. range, 1,608 f.

Cingula Sandersoni V. vi, 241.
B. range, 142 f.† Off Cape Hatteras.

Cithna tenella, var. *costulata* Jeff. vi, 184.
B. range, 2,033 f. Off Delaware Bay. Eu., Med., Azores.

Cithna cingulata V. vi, 184, pl. 32, f. 7.
B. range, 906 to 1,290 f.†; 1,467 f.*

Cithna (?) *olivacea* V. vi, 185, pl. 29, f. 5.
B. range, 193 to 1,290 f.†

Fossarus elegans V. and S. v. 522, pl. 57, f. 28. Fig. 87.
B. range, 100 to 142 f.†

Seguenzia formosa Jeff. vi, 186, pl. 31, f. 14–14*b*. Figs. 88, 88*a*.
B. range, 1,290 to 2,033 f. Eu.

Seguenzia formosa, var. *nitida* V. vi, 188.
B. range, 2,033 f. Off Delaware Bay.

Seguenzia eritima V. vi, 189, pl. 31, f. 15. Fig. 89.
B. range, 1,290 to 2,033 f.

Cerithiella Whiteavesii V. v, 522, pl. 42, f. 7.
B. range, 238 to 843 f. N.

Aporrhais occidentalis Beck.
B. range, 34 to 1,000 f.†; 115 to 349 f.* N.

PTENOGLOSSA.

Scalaria Dalliana V. and S. v, 527, pl. 57, f. 33. Fig. 91.
B. range. 85 f.†; 115 to 193 f.*

Scalaria Andrewsii V. v, 526, pl. 57, f. 35. Fig. 94.
B. range, 100 f.†; 547 f.*

Acirsa gracilis V. v, 528, pl. 57, f. 31.
B. range, 349 to 843 f.†; 487 to 547 f.*

Aclis Walleri J. v. 528, pl. 57, f. 36.
B. range, 349 f.†; 365 to 938 f.* Eu.

Ianthina fragilis Desh.
Surface.† S., O.

RHIPHIDOGLOSSA.

Rotella cryptospira V. vi, 241.
B. range, 142 f.† Off Cape Hatteras.

Ethalia multistriata V. vi, 242.
B. range, 142 f.† Off Cape Hatteras.

Leptothyra induta Watson. vi, 197.
B. range, 142 f.† Off Cape Hatteras.

Calliostoma occidentale (Mighels).
B. range, 207 f.†; 365 to 640 f.* N., Arc., Eu.

Calliostoma Bairdii V. and S. v, 530, pl. 57, f. 26. Fig. 96.
B. range, 56 to 640 f.†; 64 to 192 f.* Cb.

Margarita regalis V. and S. v, 530, pl. 57, f. 37; vi, 254, pl. 29, f. 14. Fig. 97.
B. range, 64 to 173 f.†; 193 to 1,555 f.*

Machæroplax obscura (Couth.) Friele.
B. range, 12½ to 487 f. N., Arc., Eu.

Cyclostrema Dalli V. v, 532, pl. 57, f. 39; vi, pl. 29, f. 15. Fig. 99.
B. range, 487 to 858 f.

Cyclostrema Dalli, var. *ornatum* V. vi, 255, pl. 32, f. 17.
B. range, 843 f.

Cyclostrema cingulatum V. vi, 198, pl. 32, f. 14.
B. range. 547 f.†

Cyclostrema, sp. (=*C. affine* V. vi, 199, pl. 32, f. 15, *non* Jeffreys).
B. range, 365 to 858 f.†; 843 f.*

Cyclostrema diaphanum V. vi. 199, pl. 32, f. 16.
B. range, 1,290 f.*; 2,033 f.†

Tharsis, sp. vi, 201.
B. range, 843 f.† Off Cape Hatteras.

Fissurella Tanneri V. vi, 255, pl. 29, f. 13, 13*a*.
B. range, 104 f.*; 142 f.† Southern.

Puncturella noachina (L.) Lowe.
B. range, 16 f.†; 34 to 640 f.* N., Arc., Eu.

Puncturella (Fissurisepta) *eritmeta* V. vi, 204, pl. 32, f. 19, 19*a*.
B. range, 1,451 f.

Propilidium elegans V. vi, 205.
B. range, 1,395 f. Off Chesapeake Bay.

Addisonia paradoxa Dall. v, 533; vi, 256, pl. 29, f. 10, 11–11*b*. Figs. 100, 100*a*.
B. range. 66 to 202 f.†; 71 to 156 f.* (? Eu., Med.).‡

Cocculina leptalea V. vi, 202, pl. 32, f. 20–20*b*. Fig. 101.
B. range, 1,395 to 2,033 f. Southern.

Cocculina spinigera Jeff. vi, 203.
B. range, 335 to 843 f. Eu.

Cocculina conica V. vi, 204.
B. range, 499 f. Off Nova Scotia.

Lepetella tubicola V. and S. v, 534, pl. 58, f. 29–29*a*.
B. range, 142 to 547 f.†; 134 to 396 f.* Eu.

POLYPLACOPHORA.

Hanleyia mendicaria (Migh.) Carp. v, 534.
B. range, 49 to 317 f. N. Arc., Eu., Med.

‡ By Mr. Jeffreys this species is identified with *A. eccentros* Jeff. = *Gadinia excentrica* Tib., of the Mediterranean. (Proc. Z. Soc. London, 1882, p. 673.)

Trachydermon albus (Linné.) Carp.
B. range, 99 f., off Nova Scotia. Arc., Eu.

Trachydermon exaratus (Sars). vi, 208, pl. 30, f. 2–2*b*.
B. range, 101 to 194 f. Eu.

Leptochiton alveolus (Sars) Lovén. v, 534.
B. range, 99 to 640 f. N., Eu.

Placophora (Euplacophora) *Atlantica* V. and S. vi, 206, pl. 30, f. 1, 1*b*. Figs. 102, 102*a*.
B. range, 122 to 640 f.

GYMNOGLOSSA.

Stilifer Stimpsoni V. v, 535, f. 2.
B. range, 6 to 1,255 f. N.

Stilifer curtus V. v, 535.
B. range, 410 to 1,255 f.

Eulima stenostoma Jeff. v, 536; vi, 254.
B. range, 843 to 1,451 f.*; 1,467 f.† N., Eu.

Turbonilla Rathbuni V. and S. v, 536, pl. 58, f. 15. Fig. 104.
B. range, 64 to 1,395 f.†; 100 to 365 f.*

Turbonilla Bushiana V. v, 537, pl. 58, f. 16.
B. range, 365 to 1,290 f.*; 1,451 to 1,467 f.†

Eulimella lucida V. vi, 192, pl. 32, f. 3, 3*a*.
B. range, 2,033 f.

Eulimella chariessa V. vi, 193, pl. 32, f. 4–4*b*.
B. range, 2,033 f.

Eulimella nitida V. vi, 194, pl. 32, f. 5.
B. range, 2,033 f.†

Eulimella (or *Menestho*) *lissa* V. vi, 195, pl. 32, f. 6.
B. range, 142 f. Off Cape Hatteras.

Odostomia tornata V. vi, 196.
B. range, 142 f.† Off Cape Hatteras.

Odostomia disparilis V. vi, 196.
B. range, 142 f.† Off Cape Hatteras.

TECTIBRANCHIATA.

Actæon nitidus V. v, 540, pl. 58, f. 21.
B. range, 238 to 843 f.*; 1,451 f.†

Actæon melampoides Dall. vi, 210.
B. range, 843 f.† Off Cape Hatteras. Cb.

Ringicula nitida V. v, 540.
B. range, 100 to 547 f.†; 120 to 487 f.* Cb.

Scaphander nobilis V. vi, 209, pl. 32, f. 18–18*d*. Fig. 106.
B. range, 906 f.†; 1,091 to 1,309 f.*

Scaphander puncto-striatus (Migh.) Ad.
B. range, 46 to 1,255 f.*; 1,362 to 1,467 f.† N., Arc., Eu.

Philine quadrata (Wood) Forb. and Han.
B. range, 20 to 266, f.†; 312 to 480 f.* N., Arc., Eu.

Amphisphyra globosa Lovén. v, 543.
B. range, 115 to 155 f.†; 319 to 843 f.* N., Eu.

Diaphana gemma V. v, 543, pl. 58, f. 22.
B. range, 100 to 2,033 f.

Diaphana nitidula (Lov.) v, 543.
B. range, 155 to 906 f. Eu.

Cylichna alba (Brown) Lovén.
B. range, 12 to 1,091 f.*; 1,290 f.† N., Arc., Eu.

Cylichna (?) *Dalli* V. v, 542; vi, pl. 29, f. 15.
B. range, 452 to 906 f.†; 938 to 1,290 f.*

Cylichna occulta (Migh.) Ad.
B. range, 100 to 1,467 f.*; 1,608 f.† N., Arc., Eu.

Pleurobranchœa tarda V. v, 546, pl. 58, f. 26. Fig. 105.
B. range, 28 to 640 f.

Koonsia obesa V. v, 545; vi, pl. 28 f. 7. Fig. 107.
B. range, 192 to 312 f.

NUDIBRANCHIATA.

Scyllœa Edwardsii V. v, 550, pl. 43, f. 10. Fig. 109.
Surface.* Wood's Holl; off Cape Hatteras. Oc.

HETEROPODA.

Atlanta Peronii Les. v, 529; vi, pl. 28, f. 4, 4*a*. Figs. 110, 110*a*.
B. range, 15½ to 1,608 f.† Oc.

Atlanta Gaudichaudii Eyd. and Soul. vi, 211. Fig. 111.
Surface.* Oc.

Atlanta rosea Soul. vi, 211.
B. range, 843 to 2,369 f.†; surface.* Oc.

Atlanta Lamanonii Eyd. and Soul. vi, 211.
B. range, 1,731 f.† Oc.

Atlanta pulchella V. vi, 211.
Surface.* Oc.

Atlanta inclinata Soul. vi, 211.
B. range, 516 to 843 f.†; surface.* Oc.

Firoloidea Lesueurii Eyd. and Soul.
Surface.* Station 2194.

Firola Keraudrenii Eyd. & Soul. Fig. 112.
Surface.* Stations 2038 and 2039.

PTEROPODA.

Cymbulia calceolus V. v, 553, pl. 58, f. 33. Fig. 120.
B. range, 18 to 1,467 f.†; surface.* Oc.

Cavolina tridentata (Gmelin) Gray. v, 554, f. 6, 7.
B. range, 45 to 2,033 f.†; surface.* Oc.

Cavolina uncinata (D'Orb.) Gray. v, 554. Fig. 116.
B. range, 64 to 1,608 f.†; surface.* Oc.

Cavolina longirostris (Les.) v, 555.
B. range, 64 to 2,033 f.†; surface.* Oc.

Cavolina gibbosa (Rang). vi, 213.
B. range, 193 to 1,451 f.† Oc.

Cavolina quadridentata (Lesueur). vi, 212.
B. range, 142 to 1,467 f.† Oc.

Cavolina angulata (Soul). vi, 213.
Surface.* Oc.

Cavolina inflexa (Les.) Gray. v, 555.
B. range, 487 to 1,467 f.† Oc.

Pleuropus Hargeri V. v, 555; vi, pl. 28, f. 3. Fig. 114.
Surface.* Oc.

Diacria trispinosa Gray. Fig. 115.
B. range, 64 to 1,451 f.†; surface.* Oc.

Clio pyramidata Linné. v, 555.
B. range, 64 to 2,033 f.† Oc.

Balantium recurvum Children. v, 556
B. range, 64 to 1,917 f.† Oc.

Triptera columnella (Rang). v. 557; vi, 214. Fig. 117.
B. range, 142 to 1,608 f.† Oc., S.

Styliola virgula (Rang). vi, 213.
Surface.* Oc., S.

Styliola virgula, var. *corniformis* (D'Orb.). vi, 214.
Surface.* Oc., S.

Styliola subulata (Quoy and Gaimard). vi, 213.
B. range, 15½ to 1,467 f.†; surface.* Oc., S.

Styliola recta Blainv. v, 556. Fig. 118.
Surface.* Oc., S.

Spirialis retroversus (Flem.), var. *MacAndrei* Forbes. v, 557.
B. range, 499 to 1,731 f.†; Surface.* Oc., Eu., Med.

Spirialis Gouldii St. (*? S. balea* Möll., var.).
B. range, 858 to 1,735 f.† Oc., N., Eu.

Spirialis bulimoides Soul. vi, 215.
Surface.* Oc., S.

Spirialis trochiformis Soul. vi, 214.
Surface.* Oc., S.

Clione papilionacea Pallas. Fig. 122.
Surface.* Oc., N., Arc., Eu.

Clione longicaudata Soul. vi, 215.
Surface.* Oc.

Trichocyclus Dumereilii (Oken) Esch. vi, 215.
Surface.* Oc.

SOLENOCONCHA.

Dentalium solidum V. vi, 215.
B. range, 843 to 1,309 f.

Dentalium striolatum Stimp.
B. range, 25 to 115 f.† ; 146 to 1,255 f.* N., Eu.

Dentalium occidentale Stimp. v, pl. 42, f. 16–18. **Figs. 123, 124, 125, *a*.**
B. range, 26 to 115 f.† ; 146 to 1,255 f.* N., Eu.

Dentalium occidentale, var. *sulcatum* V. vi, 217.
B. range, 75 to 1,255 f.*

Dentalium, sp. *g*. vi, 217.
B. range, 1,731 to 2,033 f. Southern.

Dentalium, sp. *h*. vi, 217.
B. range, 843 f.† ; 2,033 f.* Southern.

Siphodentalium vitreum M. Sars. v, 557, pl. 42, f. 19.
B. range, 100 f.† ; 349 to 1,290 f.* N., Arc., Eu.

Siphodentalium teres Jeff. vi, 218.
B. range, 843 f.† ; 858 to 1,290 f.* Eu.

Siphonentalis affinis (Sars). v, 558, pl. 42, f. 20, *a*, *b*.
B. range, 349 to 365 f.† ; 499 to 1,731 f.* N., Eu., Azores.

Cadulus Pandionis V. and S. v, 558, pl. 58, f. 30, 30*a*. **Fig. 126, *a*.**
B. range, 85 to 487 f.* ; 516 f.† (? Eu., Med., Af.).

Cadulus Watsoni Dall. vi, 219.
B. range, 197 to 938 f.† ; 547 to 843 f.* Cb.

Cadulus grandis V. vi, 219.
B. range, 843 to 1,290 f.† ; 906 to 1,098 f.*

Cadulus spectabilis Verrill. 1885.
B. range, 1,467 f.†

Cadulus Jeffreysii ? (Monteros.). v, 559 ; vi, 257.
B. range, 115 f.* ; 516 to 843 f.† Eu., Azores.

Cadulus subfusiformis Jeff.
B. range, 100 to 115 f. Eu., Med.

Cadulus cylindratus Jeff. vi, 220.
B. range, 1,608 f. Eu.

LAMELLIBRANCHIATA.

Teredo megotara Hanley. Fig. 127, animal.
B. range, 55 f.†; 100 to 1,467 f.*; surface* in wood. S., O., Eu.

Xylophaga dorsalis (Turt.) F. and Han. v, 559, pl. 44, f. 9.
B. range, 32 to 2,033 f. N., Eu., Med.

Ensatella Americana (Gld.) V.
B. range, 0 to 28 f.*; 64 to 89 f.† N., S.

Saxicava Norvegica (Speng.) Woodw.
B. range, 20 to 506 f.†; 300 f.* N., Arc., Eu., P.

Cyrtodaria siliqua (Speng.) Woodw.
B. range, 28 to 258 f.† N., Arc.

Poromya sublevis V. vi, 221, pl. 32, f. 21. Fig. 128.
B. range, 1,917 f.† Off Chesapeake Bay.

Neæra obesa Lovén. v, 563, pl. 44, f. 10, *c*.
B. range, 192 to 1,290 f.; 20 to 150 f. N. of Cape Cod. N., Arc., Eu., Azores.

Neæra glacialis G. O. Sars. v, 562, pl. 44, f, 10, *a*, *b*.
B. range, 64 to 547 f. N., Arc., Eu.

Neæra rostrata (Speng.) Lovén. v, 562, pl. 58, f. 39.
B. range, 65 to 487 f.†; 85 to 155 f.* N., Eu., Med., Af., Azores, Cb., Patagonia.

Neæra lamellosa M. Sars. v, 561; vi, pl. 30, f. 3.
B. range, 319 to 547 f. Eu., Med., Af.

Neæra gigantea V. vi, 223.
B. range, 1,917 f.† Off Chesapeake Bay.

Neæra undata V. vi, 223.
B. range, 2,221 f.† Off Chesapeake Bay.

Neæra, sp.
B. range, 142 f. Off Cape Hatteras.

Periploma papyracea (Say) Con.
B. range, 7 to 1,255 f. N.

Cochlodesma Leanum Couth.
B. range, 2 to 20 f.*; 65 f.† S.

Thracia Conradi Couth.
B. range, 4 to 193 f.†; 34 f.* N.

Thracia nitida V. vi, 221, pl. 32, f. 22. Fig. 130.
B. range, 1,917 f. Off Chesapeake Bay.

Pecchiolia abyssicola Sars. v. 565.
B. range, 192 to 487 f.*; 516 to 1,290 f.† N., Arc., Eu.

Pecchiolia gemma V. v, 565; vi, 258, pl. 30, f. 7, 8.
B. range, 75 to 1,290 f.†; 499 to 906 f.*

Mytilimeria flexuosa V. and S. v, 567, pl. 58, f. 38; vi, 258. Figs. 132, *a*, *b*.
B. range, 75 to 319 f.†; 349 f.*

Ceronia arctata (Con.) Ad.
B. range, 0 to 183 f.†; 0 to 2 f.* N.

Abra longicallis (Scacchi). vi, 224.
B. range, 1,467 f.† Eu., Med., Canaries, Af., Azores, Cb.

Macoma sabulosa (Speng.) Mörch.
B. range, 30 to 208 f.†; 29 to 1,255 f.* N., Arc., Eu., P., As.

Cyprina Islandica (Linné) Lam.
B. range, 8 to 128 f.*; 130 to 349 f.† N., Arc., Eu.

Astarte castanea Say.
B. range, 0 to 100 f.*; 142 to 435 f.† N., S.

Astarte undata Gld.
B. range, 8 to 480 f. N.

Astarte crenata Gray.
B. range, 34 to 640 f. N., Arc., Eu., As.

Venericardia granulata (Say)=*borealis* Con. v, 572; vi, 258.
B. range, 8 to 435 f.†; 9 to 192 f.* N.

Loripes lens V. and S. v, 569; vi, 259.
B. range, 5 to 192 f.†; 120 f.* N.

Lucina filosa Stimp.
B. range, 4 to 349 f.†; 20 to 30 f.* N.

Cryptodon subovatus (J.) V. v, 570.
B. range, 480 f.†; 499 f.* Eu., Af.

Cryptodon Gouldii (Phil.) Stimp.
B. range, 6 to 1,467 f. N., Eu.

Cryptodon obesus V. v, 569.
B. range, 12 to 100 f.†; 115 to 1,290 f.* N.

Cryptodon grandis V. 1885.
B. range, 938 f.†, 1883; 965* and 1,582 fathoms†, 1884.

Cryptodon ferruginosus (Forbes). v, 570.
B. range, 100 to 1,467 f. N. Arc., Eu., Med.

Cryptodon tortuosus (Jeff.). vi, 226.
B. range, 499 to 1,290 f. Eu.

Axinopsis, sp. nov.
B. range, 1,451 f.

Diplodonta turgida V. and S. v, 569, pl. 58, f. 42; vi, pl. 30, f. 10, 11. Figs. 135, 136.
B. range, 65 to 98 f.†

Montacuta tumidula Jeff. vi, 225.
B. range, 843 to 1,091 f. Southern. Eu.

Kelliella, sp. nov.
B. range, 2,033 f.

Yoldia thraciformis (Storer) Stimp. Figs. 137, 138, animal.
B. range, 29 to 182 f.†; 192 to 906 f.* N.

Yoldia sapotilla (Gld.) Stimp. Fig. 139, animal.
B. range, 4 f.†; 12 to 321 f.* N., Arc.

Yoldia expansa Jeff.
B. range, 365 f.*; 1,451 to 1,467 f.† Eu.

Yoldia lucida Lovén. v, pl. 44, f. 1.
B. range, 29 to 1,608 f.†; 115 to 1,290 f.* N., Arc., Eu., Med.

Yoldia frigida Torell. v, 573, pl. 44, f. 2.
B. range, 157 to 1,255 f. N., Arc., Eu., Med., As.

Yoldia Jeffreysi (Hidalgo). vi, 229.
B. range, 349 f.*; 499 to 1,290 f.† Eu., Med., Af., Azores, Cb.

Yoldia subequilatera (Jeff.). vi, 229.
B. range, 499 to 1,731 f. Eu., Arc.

Yoldia sericea Jeffreys, var. *striolata* J. vi, 226.
B. range, 516 to 1,731 f. Eu.

Yoldia Messanensis (Seguenza), var. vi, 227.
B. range, 1,451 to 2,033 f.†; 1,467 f.* Eu., Med., Azores, Cb.

Leda Bushiana V. vi, 229.
B. range, 516 f. Off Cape Hatteras.

Leda tenuisulcata (Couth.) Stimp.
B. range, 25 to 120 f.†; 640 f.* N.

Phaseolus ovatus ? (Jeff. MSS.). vi. 230.
B. range, 1,290 f. (? Eu.)

Malletia obtusa (M. Sars) Mörch. vi, 226.
B. range, 516 f.†; 788 to 1,608 f.* Eu., Med.

Glomus nitens Jeff. vi, 231.
B. range, 1,608 f.† Eu.

Nucula delphinodonta Mighels.
B. range, 10 to 1,290 f. N., Arc., Eu.

Nucula proxima Say.
B. range, 3 to 302 f.*; 310 to 516 f.† S.

Nucula tenuis (Mont.) Turton.
B. range, 75 to 266 f.†; 302 to 1,255 f.* N., Arc., Eu., Med., Cb., P., As.

Nucula cancellata Jeff. vi, 231.
B. range, 858 f.†; 906 to 2,033 f.* Eu., Azores.

Nucula granulosa Verrill. vi, p. 280.
B. range, 487 to 858 f.*

Arca pectunculoides Sc. v, 573, pl. 44, f. 6.
B. range, 79 to 640 f. N., Eu., Med., Cb.

Arca pectunculoides, var. *septentrionalis* Sars. v, 573.
B. range, 79 to 640 f. N., Arc.

Limopsis minuta (Phil.). v, 576.
B. range, 64 to 115 f.†; 120 to 2,221 f.* N., Arc., Eu., Med., Af., Azores.

Limopsis cristata Jeff. v, 577; vi, 231.
B. range, 549 f.† Eu., Med.

Limopsis plana Verrill, 1885.
B. range, 197 to 2,221 f.

Limopsis tenella Jeff. vi, 232.
B. range, 1,731 to 2,033 f. Eu.

Mytilus edulis Linné.
B. range, 0 to 57 f.*; 1,608 f.† (perhaps from surface *Fuci*). Oc., S., N., Arc., Eu., Med., P., Antarctic.

Modiola modiolus (Linné) Turton.
B. range, 0 to 115 f.*; 202 f.† N., Arc., Eu., P., As.

Modiolaria discors (Linné) Lovén.
B. range, 15 to 90 f. N., Arc., Eu., Med., P., As.

Idas argenteus Jeff. v, 579; vi, pl. 30, f. 16, 16*a*.
B. range, 335 to 2,033 f.* in wood. Surface? (in wood). Eu.

Dacrydium vitreum (Möll.) Torell. v, 579, pl. 44, f. 8, 8*a*.
B. range, 300 f.†; 312 to 1,555 f.* N., Arc., Eu., Med., Af., Azores.

Pecten Clintonius Say. vi, 261.
B. range, 8 to 349 f.†; 13 to 146 f.* N.

Pecten Islandicus Müller.
B. range, 33 to 122 f.*; 124 to 194 f.† N., Arc., Eu., P., As.

Pecten glyptus V. v. 580.
B. range, 69 to 156 f.†

Pecten vitreus (Gmel.) Wood. v, 580, pl. 42, f. 21.
B. range, 57 to 64 f.†; 100 to 787 f.* N., Arc., Eu., Med., Af.

Pecten pustulosus V. v, 581, pl. 42, f. 22, 22*a*; vi, 261. Figs. 142, *a*.
B. range, 99 to 321 f.*; 365 to 547 f.† N., Eu.?

Pecten leptaleus V. vi, 232.
B. range, 142 f. Off Cape Hatteras.

Pecten fragilis Jeff. vi, 232.
B. range, 843 f. Off Cape Hatteras. Arc., Eu., Azores.

Limæa subovata (Jeff.) Monteros. v, 580.
B. range, 100 to 1,362 f.†; 252 to 1,290 f.* Eu., Arc., Med., Azores.

Avicula hirundo, var. *nitida* V. v, 582, pl. 58, f. 43.
B. range, 64 to 192 f. Oc.

Avicula squamulosa? Lam. vi, 233.
Surface. S., Oc.

Anomia aculeata Müll.
B. range, 4 to 640 f. N., Arc., Eu.

BRACHIOPODA.

Terebratulina septentrionalis (Couth.)
B. range, 16 to 396 f. N., Arc., Eu., Af.

Waldheimia cranium (Müller) Davidson. vi, 234.
B. range, 1,362 f.†. Arc., Eu., P.

Discina Atlantica King. vi, 233.
B. range, 1,251 to 1,467 f.† Eu., Arc., Med., Australia.

FAUNA OF THE SHALLOW WATER NEAR CAPE HATTERAS.

The first and the last trips of the season were made to the waters off Chesapeake Bay and Cape Hatteras. In that region, besides some interesting hauls that were made in deep water, a few were made in shallow water, during the stormy weather encountered on the last trip. These were near the coast, in 15 to 145 fathoms (stations 2107 to 2109, 2112 to 2114). They proved to be of great interest, for scarcely anything had been previously known respecting the fauna inhabiting the outside waters, in moderate depths, off our Southern Atlantic coasts north of Florida, most of the inshore collecting in that region having been carried on in the harbors and sheltered sounds, while the dredgings by the "Blake" and "Fish Hawk" were mostly in deep water far from the shore.

From these few shallow-water dredgings made by the "Albatross" a large number of interesting additions to the known Mollusca of the Atlantic coast have been obtained. Many of these are West Indian species, not known before from north of Cuba, while a considerable number are undescribed. Among the interesting discoveries was a handsome living *Conus* of good size, from 48 fathoms. It resembles the *Conus Delessertii* Recluz. The general character of the Mollusca is decidedly more tropical, or rather "warm-temperate," than that of the shore fauna of the adjacent coast. But with the southern forms, such as species of *Conus*, *Oliva*, *Olivella*, *Marginella*, *Cancellaria*, *Semicassis*, *Solarium*, &c., there are also many northern species, common on the New England coast, but hitherto not known to live so far south. It appears very strange to see West Indian and northern or even Arctic species mingled together in the same haul of the dredge. The mildness and unusual uniformity of temperature during the whole year, due to the greatly diminished volume, or absence of the arctic current, over

the inshore plateau, and to the effect of the Gulf Stream in winter, are doubtless the causes of this peculiar assemblage.

These shallow-water shells, which are mostly of small size, have been studied with care by Miss K. J. Bush, who has identified many of the known species and described several of the new ones. I am greatly indebted to her for the accompanying list of the species already determined, but the study of these shells is not yet completed, and this list must, therefore, be regarded only as a partial one.‡

The representatives of other groups were of less importance than the shells, but several interesting southern species of Echinoderms and Anthozoa were taken, of which the bathymetrical range is little known. Among these were specimens of the branched coral, *Oculina implicata* V., and the leaf-like *Renilla reniformis* Cuv. The southern shallow-water star-fishes, *Luidia clathrata* Say and *Astropecten articulatus* Say, also occurred in these localities, in 14 to 25 fathoms. During the more extended explorations in the same region in 1884, *Ophiothrix angulata* and *Amphiura elegans* (= *tenuis* Ayres) occurred in 16 fathoms, while the curious West Indian *Astroporpa annulata* occurred several times, of large size, clinging to the Gorgonian, *Titanideum suberosum* V., in 48 to 68 fathoms.

LIST OF THE SHALLOW-WATER MOLLUSCA DREDGED OFF CAPE HATTERAS BY THE "ALBATROSS" IN 1883.

BY MISS K. J. BUSH.

The following list is not intended as a complete list of the shells of this region, but is nearly complete for the work of 1883. Many additional species were dredged in the same region, in the autumn of 1884. The bathymetrical range refers only to the collection of 1883. Most of the common species also occur in very shallow water in the harbor of Beaufort, N. C., or even at low-water mark. An asterisk (*) indicates specimens living; a dagger (†), dead shells only.

CEPHALOPODA.

Sthenoteuthis Bartramii (Lesueur) Verrill.
Surface.*

GASTROPODA.

TOXOGLOSSA.

Conus Delessertii (?) Recluz.
B. range, 48 fathoms.*

‡ Another and more extensive series of dredgings in shallow water in the same region was made by the "Albatross" in 1884, by which a much larger collection was obtained, including, besides many additional Mollusca, a great variety of interesting Crustacea, among which there are many species not before known from the Atlantic coast of the United States. The additions to the Brachyura are especially interesting and numerous. Many are Floridian and West Indian species.

Mangilia rubella Kurtz and Stimpson.

B. range, 14 fathoms; † 15 fathoms.*

Mangilia cerina (Stimp.) Verrill.

B. range, 14 to 15 fathoms.†

Mangilia ephamilla Bush, sp. nov.

B. range, 14 to 15 fathoms; † 48 fathoms.*

Shell of moderate size, rather stout, with a regularly tapered, acute spire, consisting of about five sharply angulated whorls below the nucleus. Suture marked by a distinctly raised, rounded, undulating, spiral thread. Nucleus small, prominent, semi-transparent, glassy, composed of about two and a half turns, with a small, rather prominent apical whorl, which, with the second, is very smooth; the third is crossed by delicate, curved, transverse riblets, which are rendered somewhat nodulous by the intersection of a single, faint, revolving, median thread; the others have about nine broad, prominent, acute, straight, longitudinal ribs extending from suture to suture, and separated by deep, concave interspaces about equal in width to the ribs. The whole surface is covered with distinctly raised, rounded cinguli and microscopic threads, which are roughened by the intersection of the fine lines of growth, and, under the microscope, have the appearance of being covered with minute grains of sand. The cingulus at the center, defining the shoulder of the whorls, is the most conspicuous; above this there are about five finer ones, and below, on the whorls of the spire, two or three, the number increasing to ten or twelve on the body-whorl. The aperture is a little less than half the length of the shell, narrow, oblong, broadest at its posterior third, pinched up anteriorly into a straight, slightly elongated canal. Outer lip thin (broken); inner lip inconspicuous. No operculum.

Color in alcohol deep yellow, with white ribs and canal.

Length of largest specimen, 6.5^{mm}; breadth, 3^{mm}; length of aperture, 3^{mm}; its breadth, .5^{mm}.

One living specimen (No. 35,404) was taken at station 2,108; also, young dead specimens at stations 2,112 (No. 35,884), and at 2,114 (No. 35,515).

This species is closely allied to *M. cerina*, but differs in having a stouter form, more angularly shouldered whorls, and especially in having very prominent, straight ribs extending from suture to suture.

Mangilia melanitica Dall, var. *oxia* Bush.

B. range, 14 to 15 fathoms.*

Shell small, slender, fusiform, lustrous, transparent, glassy, with a tall, regularly tapered, acute spire; whorls eight, slightly convex, angulated, carinated, with the suture defined by a distinct, smooth, rounded thread; nucleus large, acute, consisting of three and a half rapidly tapering coils, with a small, very prominent, decidedly upturned apical

whorl, smooth, with the exception of a distinct median keel on the two lower whorls. Sculpture consists of about seventeen very thin, slightly raised, strongly recurved riblets extending from suture to suture, rendered nodulous by the intersection of a rather broad, smooth, rounded median carina. The greatest curvature of the transverse riblets is above the carina on the wide, slightly concave subsutural band, which is crossed also by the lines of growth, and in some specimens by numerous microscopic revolving striæ. On the body-whorl, from the posterior end of the aperture to the end of the canal, there are about twelve rather fine, smooth, rounded cinguli; the first, situated just above the suture and a little wider and more prominent than the others, is rendered nodulous by the crossing of the transverse riblets, at which they abruptly end, and is separated from the second by a rather wide, smooth space, crossed only by the microscopic lines of growth; the space between the others decreases so that, on the canal, they are rather close together. On some of the specimens, there is an additional cingulus midway between the carina and the first cingulus; and three or four of the transverse riblets, and sometimes all of them, on the dorsal surface, extend as nearly straight lines to the base of the canal. The aperture, in immature specimens, is rather broad-ovate, with a thin, slightly curved outer lip, having a very shallow, wide posterior sinus, and the columella has a slight sigmoid curvature, most decided at its posterior third, while in more mature specimens the aperture is very narrow-oblong, with a very much thickened outer lip, forming a conspicuous white varix with a thin brown edge bending in and partly closing the aperture, and with a deep, narrow, oblique sinus considerably below the suture. Some specimens have about four smooth, raised, rounded, revolving threads on the interior of the aperture, which form, by their abrupt terminations, conspicuous nodules within the margin of the outer lip. The outer lip also increases posteriorly and joins the inner lip a little below the suture, thus considerably shortening the aperture. Columella nearly straight, with a row of from four to six very minute white crenulations just within the thin free edge of the inner lip; canal very short, narrow at its base, but suddenly widened by the abrupt outward turning of the lip.

Color of fresh specimens, when dry, amber, with lighter tinted carina, and red-brown edged aperture; some specimens are also irregularly spotted with red-brown.

Length of a medium-sized mature specimen, 5^{mm}; its breadth, 2^{mm}; length of aperture, 1.75^{mm}; its breadth, $.5^{mm}$. A specimen without the thickened lip has an aperture 2^{mm} long and nearly 1^{mm} broad.

Found in large numbers, both living and dead.

Mr. W. H. Dall considers this shell identical with a species from Florida to which he has given the name, *melanitica* (MSS.), but admits a varietal difference.

Mangilia oxytata Bush, sp. nov.

B. range, 48 fathoms.†

At station 2,108, a single dead specimen (No. 35,395), somewhat resembling the preceding, was taken.

It consists of about eight whorls; those of the spire strongly angulated just below the middle, and ornamented with about nine rather prominent, straight, transverse ribs, commencing at the periphery and extending to the suture; these, with their wide, concave interspaces, are crossed by three rather strong, nearly smooth, rounded, equally distant carinæ, the third defining the suture. Smooth, oblong nodules are formed by the intersection of these with the ribs, those on the periphery being the most conspicuous, as the first carina is slightly wider than the other two. The subsutural band is wide, slightly concave, crossed by delicate, excurved, raised lines or riblets extending from the suture to the median carina, and by three or four fine, slightly raised, equally distant, revolving threads. The nucleus is large, semi-transparent, shining, composed of four and a half turns, with a small, exceedingly prominent, decidedly upturned, apical whorl, which, with the two following, is smooth and glassy; the next two have a fine, smooth median carina. On the body-whorl the ribs continue to the base of the siphon, and are crossed by small, nearly smooth, rounded, equally distant cinguli, which commence a little below the third principal carina and continue to the end of the canal. The entire surface is covered with very minute microscopic granules. Aperture narrow-ovate, pinched up anteriorly into a short, rather narrow, straight canal. Outer lip very much thickened, with a conspicuous varix and a thick, smooth, rounded, very irregularly curved, light brown edge, and a deep, narrow sinus considerably below the suture, at the angle of the shoulder; inner lip inconspicuous; columella slightly curved.

Color yellowish white, tinged with brown just below the suture, and on the anterior part of the body-whorl.

Length, 5^{mm}; breadth, 2.5^{mm}; length of aperture; 2^{mm}; its breadth, 1^{mm}.

This species, although closely resembling the preceding, is sufficiently characterized in having a much stouter form, more acute apex, more angularly shouldered whorls, fewer and more prominent ribs, more numerous cinguli, and especially in having its entire surface microscopically granulated.

Mangilia ? glypta Bush, sp. nov.

B. range, 48 fathoms.†

Shell small, semi-transparent, fusiform, with about five slightly convex whorls below the nucleus, which consists of three and a half smooth, transparent, white, glassy, regularly increasing turns. The apical whorl is small, not very prominent, somewhat oblique. The sculpture consists of about ten rather indistinct, narrow, longitudinal ribs, and broad,

rounded, very conspicuous cinguli, which, in crossing the ribs, form prominent, smooth, white, oblong beads or nodules; there are three rows of these on the whorls of the spire, and five or six on the body-whorl, the second and third below the suture being more prominent and farther apart than the others. Cinguli without nodules continue to the end of the canal, the transverse ribs disappearing at its base. Aperture a little more than one-third the length of the shell, narrow-ovate, pinched up anteriorly into a very narrow, short canal; outer lip thickened, forming a slight varix, with a thin, white edge and a shallow sinus, close to the suture, with one or two minute white crenulations just within its posterior edge; there are also about five similar but much larger crenulations on the inner margin of the lip, extending from the sinus to the base of the canal. Inner lip continuous with the outer, with a free, thin, white edge, having four or five minute white crenulations just within its inner margin. Canal short, narrow, bent slightly backward at its anterior end, with a decided, but shallow, notch.

Color of dead specimens, in alcohol, light brown; when dry, dirty white. One fresh specimen has a light brown, lamellose epidermis. It may belong to *Pisania.*

Length of a specimen with imperfect nucleus, 5^{mm}; its breadth, 2.5^{mm}; length of aperture, 2.5^{mm}; its breadth, 1^{mm}.

Three imperfect specimens, (No. 35,363) were taken at station 2,108.

Acus dislocatus (Say).
B. range, 14 to 15 fathoms.†

Acus concavus (Say).
B. range, 14 to 15 fathoms.†

Acus protextus (Conrad) Dall.
B. range, 48 fathoms.†

Cancellaria reticulata (Linné).
B. range, 14 fathoms.†

RACHIGLOSSA.

Oliva literata Lamarck.
B. range, 14 to 15 fathoms.*

Olivella mutica (Say).
B. range, 14 to 15 fathoms;* 48 fathoms.†

Fulgur carica Conrad.

Nassa consensa Ravenel.
B. range, 14 to 48 fathoms.†

Tritia trivittata (Say) H. & A. Adams.
B. range, 14 to 15 fathoms.†

Eupleura caudata (Say) H. & A. Adams.
B. range, 15 fathoms.†

Anachis avara (Say) Perkins.
B. range, 14 fathoms;† 48 fathoms.*

Columbella ornata Ravenel.
B. range, 14 to 15 fathoms.†

Astyris pura Verrill.
B. range, 14 fathoms;* 15 fathoms.†

Astyris lunata (Say) Dall.
B. range, 14 to 15 fathoms;† 48 fathoms.*

TÆNIOGLOSSA.

Semicassis granulosa (Bruguiere).
B. range, 15 fathoms, fragment.

Neverita duplicata (Say) Stimpson.
B. range, 0 to 14 fathoms †; 15 fathoms.*

Natica pusilla Say.
B. range, 14 to 15 fathoms.*

Sigaretus perspectivus Say.
B. range, 15 fathoms.†

Crepidula fornicata Lamarck.
B. range, 15 fathoms;† 48 fathoms.*

Crepidula plana Say.
B. range, 15 to 48 fathoms.†

Crepidula convexa Say.
B. range, 15 fathoms.†

Cerithiopsis Emersonii (Adams).
B. range, 14 to 15 fathoms.†

Cerithiopsis terebralis (Adams).
B. range, 14 fathoms.†

Triforis turris-thomæ (D'Orbigny) Dall.
B. range, 14 fathoms.†

Vermetus radicula Stimpson.
B. range, 14 to 15 fathoms.†

Cæcum pulchellum Stimpson.
B. range, 14 to 15 fathoms.†

Cæcum Cooperi Smith.
B. range, 14 to 15 fathoms.†

Skenea trilix Bush, sp. nov.
B. range, 14 to 15 fathoms.*

This species closely resembles *Adeorbis supranitida* Wood, in form and sculpture, but it has a thin, horny operculum and an animal like *Skenea*.

PTENOGLOSSA.

Scalaria lineata Say.
B. range, 14 to 15 fathoms.†

Scalaria multistriata Say.

B. range, 14 to 15 fathoms.†

Scalaria angulata Say.

B. range, 14 to 15 fathoms.†

Solarium granulatum Lamarck.

B. range, 48 fathoms.*

RHIPHIDOGLOSSA.

Fissurella alternata Say.

B. range, 14 fathoms.†

GYMNOGLOSSA.

Obeliscus crenulatus Holmes.

B. range, 15 fathoms;† 48 fathoms.*

Eulima oleacea Kurtz and Stimpson.

B. range, 15 fathoms.†

Niso æglees Bush, sp. nov.

B. range, 14 to 15 fathoms.*

Shell of moderate size, regularly tapered, conical, thin, semi-transparent, smooth, shining, consisting of about twelve closely coiled, flattened whorls, with the suture indistinct, defined by a thread of dark, chestnut-brown, above and below which there is an indefinite band of yellowish-white, gradually shading, towards the center of the whorls into light yellow or brown, sometimes mingled with purple. The nucleus is small, consisting of about three regularly coiled whorls of a light purple or amethystine color. Base prominent, angulated, with a moderately large and deep umbilicus, margined by a dark chestnut-brown thread. Aperture nearly quadrangular, the angles being formed at the termination of the dark threads, defining the base and the umbilical region, somewhat produced at the anterior angle, forming an indistinct notch. Outer lip thin, with a dark chestnut-brown edge; inner lip regularly curved, slightly reflected over the umbilicus, with a somewhat thickened, dark chestnut-brown edge; just back of this there runs across the base, from within the umbilicus to the sutural thread, a thread or streak of the same dark chestnut-brown color, and throughout the entire length of the shell, with the exception of the nucleus, similarly colored streaks occur, crossing the whorls at irregular intervals. In specimens somewhat eroded, fine but distinct lines of growth cross the whorls at pretty regular intervals, and even in fresh specimens indications of them are occasionally seen. Operculum horny, very thin, light yellow.

Length of the largest specimen, 7.5^{mm}; its breadth, 3.5^{mm}; length of aperture, 2.5^{mm}; its breadth, 2^{mm}.

A few living and several dead specimens were taken.

Odostomia cancellata (D'Orbigny).

B. range, 14 to 15 fathoms.†

TECTIBRANCHIATA.

Philine Sagra (D'Orbigny).
B. range, 15 fathoms.†

Cylichna biplicata (Lea).
B. range, 14 to 15 fathoms.*

Volvula, sp. nov.
B. range, 14 to 15 fathoms.*

Bulla Candei D'Orbigny.
B. range, 15 fathoms.†

Utriculus canaliculatus (Say) Stimpson.

Pleurophyllidia Cuvieri Meckel.
B. range, 15 fathoms.*

HETEROPODA.

Atlanta Peronii Lesueur.
B. range, 15 to 843 fathoms.†

Atlanta inclinata Souleyet.
B. range, 15 to 843 fathoms.†

PTEROPODA.

Cavolina uncinata (D'Orbigny) Gray.
B. range, 48 to 843 fathoms.†

Cavolina longirostris Lesueur.
B. range, 14 to 938 fathoms.†

Cavolina quadridentata (Lesueur).
B. range, 15 to 192 fathoms.†

Diacria trispinosa Gray.
B. range, 15 to 843 fathoms.†

Clio pyramidata Linné.
B. range, 48 to 938 fathoms.†

Styliola virgula (Rang).
B. range, 15 fathoms.†

Styliola subulata (Quoy and Gaimard).
B. range, 15 to 843 fathoms.†

Styliola recta Blainville.
B. range, 15 fathoms.†

SOLENOCONCHA.

Dentalium leptum Bush, sp. nov.
B. range, 14 to 15 fathoms.†

Shell of moderate size, very slender, slightly curved posteriorly, rather thin, delicate, with a very smooth and glossy surface, destitute of sculpture, except at the posterior end, which is covered with numerous,

crowded, very fine, raised, longitudinal lines visible only under the lens. Anterior aperture round with a sharp, thin edge; posterior aperture somewhat thickened, very small, round, slightly oblique, with a deep, narrow, dorsal notch. Color delicate salmon, or yellow, gradually shading into white toward the anterior end. Several dead specimens.

Length, 31.5^{mm}; diameter of anterior aperture, 2^{mm}; posterior aperture, about .5^{mm}.

Cadulus Carolinensis Bush, sp. nov.

B. range, 14 fathoms;† 15 to 48 fathoms.*

Shell of medium size, semi-transparent, very glossy, white, circular throughout its entire length. Greatest diameter at about the anterior third, diminishing slightly to the round, very oblique, anterior aperture, and backward to the posterior end, at first very gradually and farther back very rapidly. Curvature well marked in some specimens, very slight in others, nearly uniform dorsally; but ventrally, most decided in the posterior third. Posterior aperture very small, round, a little oblique, with four small, distinct notches, two on each side. A few living, and many dead specimens.

Length, 9.5^{mm}; greatest diameter, about 2^{mm}; diameter of anterior aperture, 1^{mm}; posterior aperture, .4^{mm}.

LAMELLIBRANCHIATA.

Ensatella Americana (Gould) Verrill.

B. range, 15 fathoms.†

Corbula disparilis D'Orbigny.

B. range, 14 to 15 fathoms.†

Corbula Swiftiana C. B. Adams.

B. range, 14 to 15 fathoms; † 48 fathoms.*

Neæra costata Bush, sp. nov.

B. range, 48 fathoms.*

Shell moderately thick, compressed, triangular-ovate, with a contracted and somewhat elongated rostrum, and with three or four very prominent, curved, distant, radiating ribs on the convex part of the valves, and with a few smaller and closer ones anteriorly. Umbos high, smooth; beaks somewhat curved backward. The dorsal margin, from the beaks to the end of the rostrum, is strongly and regularly concave, the rostrum being a little upturned or straight at the tip; anteriorly, the dorsal margin is convex, and falls off abruptly to the obtusely rounded anterior end. The ventral margin is broadly rounded and projects outward in an acute angle at the projection of each of the principal ribs; the intervals between these angles are usually concave, and beyond the hindermost rib the outline recedes in a concave curve to the origin of the rostrum, which is rapidly narrowed to near the tip. Of the three principal radiating ribs, the middle one runs from the beak nearly to

the middle of the ventral margin, curving a little backward; the hindermost terminates about midway between the former and the end of the rostrum, curving strongly backward; the most anterior one ends about midway between the middle one and the anterior end of the shell; midway between this and the middle one, there is a smaller secondary rib. These three primary ribs are strongly elevated, not very broad, with the summit rather thin, finely notched by the concentric lines of growth; the most posterior rib is the largest and highest, and projects most at the margin. Between these ribs the spaces are wide and strongly concave, marked by numerous and regular lines of growth. On the anterior end of the shell there are two or three smaller radiating ribs, which are separated by intervals about equal to their own breadth, and give the margin a slightly crenulated appearance. The rostrum is narrow, strongly compressed, with both the dorsal and ventral outline concave. Two small ridges run from the beak to the tip of the rostrum, separated by a very narrow, flattened area. The right valve has two well-marked lateral teeth, the posterior one considerably longer and larger than the anterior; between these there is a small, ovate cartilage-pit. The inner surface of the valves shows deeply indented grooves corresponding to the primary external ribs. Color, opaque white. Epidermis indistinct.

Length of the largest specimen, 6^{mm}; height, 4^{mm}; thickness, 4^{mm}.

Four living and one dead specimens (No. 35,362) were found at station 2,108.

This species bears considerable resemblance to *N. ornatissima* D'Orb., but the ribs are less numerous, more curved, and the primary ones are much larger and more widely separated, and the shell is less convex. There is no other similar species known from the Atlantic coast.

Clidiophora trilineata (Say) Carpenter.
B. range, 14 to 15 fathoms.†

Pandora, sp.
B. range, 14 to 48 fathoms.†

Spisula solidissima (Dillwyn) Gray.
B. range, 14 to 15 fathoms.†

Macha strigillata (Linné), var. (?)
B. range, 15 fathoms.†

Tellina alternata Say.
B. range, 15 fathoms.†

Tellina lintea Conrad.
B. range, 14 to 15 fathoms.†

Tellina iris Say.
B. range, 15 fathoms.*

Angulus tener (Say) Adams.
B. range, 14 to 15 fathoms;* 48 fathoms.†

Strigilla flexuosa (Say).
B. range, 15 fathoms.†

Abra æqualis Say.
B. range, 14 fathoms;* 15 to 48 fathoms.†

Mulinia lateralis (Say) Gray.
B. range, 14 to 15 fathoms.†

Venus mercenaria Linné.
B. range, 14 to 15 fathoms.†

Dosinia discus Reeve.
B. range, 14 to 15 fathoms.†

Dosinia obovata (Conrad).
B. range, 14 to 15 fathoms.†

Chione trapezoidalis ? (Kurtz).
B. range, 14 to 15 fathoms.†

Chione alveata (Conrad).
B. range, 15 to 48 fathoms.†

Callista convexa (Say) H. & A. Adams.
B. range, 15 to 48 fathoms.†

Callista gigantea Chemnitz.
B. range, 15 fathoms.†

Callista maculata (Linné).
B. range, 15 fathoms.† (Young.)

Venericardia tridentata Say.
B. range, 15 fathoms.†

Cardium magnum Born.
B. range, 14 to 15 fathoms.†

Cardium pinnulatum Conrad.
B. range, 15 to 48 fathoms.†

Chama congregata Conrad.
B. range, 14 fathoms.†

Lucina filosa Stimpson.
B. range, 48 fathoms.†

Lucina crenulata Conrad.
B. range, 14 to 15 fathoms;† 48 fathoms.*

Lucina nassula Conrad.
B. range, 14 to 15 fathoms.†

Cyclas dentata (Wood).
B. range, 14 to 15 fathoms.†

Cryptodon obesus Verrill.
B. range, 15 to 48 fathoms.†

Diplodonta punctata Say.
B. range, 14 fathoms.†

Montacuta bidentata (Montagu).
B. range, 48 fathoms.*

Leda unca Gould.
B. range, 14 to 48 fathoms.†

Nucula proxima Say.
B. range, 14 to 15 fathoms;† 48 fathoms.*

Scapharca transversa (Say) H. & A. Adams.
B. range, 14 to 15 fathoms.†

Argina pexata (Say) Gray.
B. range, 14 to 15 fathoms.†

Pinna seminuda Lamarck.
B. range, 14 to 48 fathoms.†

Pecten dislocatus Say.
B. range, 14 to 15 fathoms;† 48 fathoms.*

Anomia glabra Verrill.
B. range, 15 fathoms.†

Ostrea equestris Say.
B. range, 14 fathoms.†

FAUNA OF THE SURFACE WATER OF THE GULF STREAM.

Collections of the invertebrate surface fauna were made at many localities during this and previous seasons in the waters of the Gulf Stream, both by means of hand-nets and towing nets, while porpoises (*Delphinus delphis*), sharks, and fishes of various kinds have been taken by the use of harpoons and hooks. By the use of muslin nets, known as "trawl-wings," attached to the ends of the trawl frame, so as to be somewhat above the bottom, many pelagic species have been obtained which have not occurred in the surface nets. It is impossible, however, in many cases to know whether such species actually live at or near the bottom, at the surface, or in intermediate depths, for they are liable to enter these nets at any time during the descent or ascent of the trawl, as well as during the time that it is on the bottom. The trawl-wings have, however, furnished a large number of species, of various groups, which we have never taken in any other way, and it is probable that many of these live swimming free, either near the bottom or at various depths intermediate between the surface and bottom, where the temperature may best suit them. In the surface nets a great many eggs and young of fishes of various kinds are usually taken, the young fishes varying in size from those just hatched up to 2 or 3 inches in length.

Copepod crustacea are usually the most abundant forms of small surface animals, occurring in great quantities and of many genera and species. Various species of the genus *Calanus* are the most common.

Several species of the genus *Saphirina* were taken, some of them very brilliant in colors; also many small shrimp belonging to the Macrura and Schizopoda, and various species of Amphipoda and Isopoda.

The Isopods are usually found clinging to floating sea-weeds (*Sargassum* and *Fucus*) or other floating objects, but are capable of swimming about free. The most common species is *Idotea robusta*, which is a particularly oceanic species, remarkable for its metallic luster and bluish color. The commonest Amphipods are *Themisto bispinosa*, which often occur in vast numbers, both at the surface and in the trawl-wings, and *Calliopius læviusculus*, which is very common and often abundant at the surface. There are also several species of *Hyperia* and allied genera that live parasitic on jelly-fishes.

The most interesting and beautiful Amphipod is a species of *Phronima* (fig. 163). It is almost transparent and colorless, with the exception of the black eyes. It is about an inch long and lives in a transparent, gelatinous, tubular case or dwelling, which is open at both ends, and usually about an inch in length and nearly as much in diameter. By forcing a current of water through this tube it swims about with considerable rapidity. Clusters of pinkish young ones are often seen attached to the inside of the case. The curious structures or cases inhabited by this species are not all alike, some being smooth and others longitudinally ribbed or keeled, the ribs having serrated edges. The ribbed cases are evidently made from the posterior half of the test of a large *Salpa*, common in the same waters, and having the same serrated ribs. Perhaps the smooth ones are made from other species of *Salpa* and *Doliolum*. Among the surface crustacea are delicate species of the curious genus *Lucifer* (*L. typus?*). Among the common small shrimp are *Latreutes ensiferus*, which is very abundant, and *Leander tenuicornis*, of somewhat larger size. The Schizopod shrimp, *Nyctiphanes Norvegica*,* is often taken in the trawl-wings with several other related species. Sometimes it is very abundant at the surface, especially northward.

Two species of free-swimming oceanic crabs (*Nautilograpsus minutus* and *Neptunus Sayi*) are of common occurrence, usually clinging to the clusters of floating sea-weeds, which they imitate in colors, but swimming rapidly away when disturbed. The young of various crabs in the zoëa and megalops stages are taken in the surface nets, as well as the curious larval forms of *Palinurus*, *Squilla*, and allied genera.

Several oceanic barnacles, especially *Lepas pectinata* and *L. fascicularis*, occur attached to floating drift-wood and other objects, and in one case a small barnacle of this group occurred attached to a living siphonophorous jelly-fish (*Porpita*). Several oceanic annelida were taken, while larval forms of annelids are not uncommon. Among the latter was a very large larva, probably of *Chætopterus*, but much larger than that of the shore species. The larval forms of Echinoderms are not uncommon.

* Prof. G. O. Sars refers this species to a new genus (*Nyctiphanes*) recently established by him. It is the *Thysanopoda Norvegica* Kröyer

The oceanic mollusca are numerous in the Gulf Stream, even as far north as our explorations extended, though doubtless far less abundant than farther south. More than twenty-five species of Pteropods occur living in the region explored, and many of them were taken in the surface nets, though other species were caught only in the trawl-wings, which they probably entered, in most cases, when the trawl was at or near the surface. Most of these Pteropods are very delicate and beautiful forms, with glassy or amber-like transparent shells of various shapes. Those taken in 1883 are all enumerated in the general list of mollusca (p. 70).

At least a dozen species of the curious Heteropods have also been taken by us in the same region. The most abundant of these are the flat, spiral, glassy, and broadly-keeled shells of several species of *Atlanta* (figs. 110, 111). Two transparent naked species, belonging to *Firola* (fig. 112) and *Firoloides* are not uncommon, and *Carinaria*, with its glassy, slipper-like shell, is sometimes taken. Several species of naked mollusks (Nudibranchiata) also occur in the same region. One of the largest and most frequent of these is the *Scyllæa Edwardsii* V. (fig. 109), which clings to the floating fucus and sargassum, and imitates in a marvelous manner the colors, forms, and ornamentation of these sea-weeds. Another large and interesting species (*Fiona nobilis*) has been found several times among the brown and yellow stems of barnacles (*Lepas*) attached to floating timber. It deposits its eggs in inverted cup-shaped, or funnel-shaped, clusters, attached by a little pedicel at the small end.

A very curious and beautiful free-swimming species (*Glaucus margaritaceus*, figs. 113, *a*, *b*) was taken in 1884. It is bright blue and silvery in life.

Some of the species of Cephalopods are taken alive at the surface, but most of them are difficult to capture. One living specimen of the paper-nautilus (*Argonauta argo*, figs. 63, *a*, *b*) was caught in 1882 in a hand-net by Dr. Kite, on the "Fish Hawk." The most abundant Gulf Stream species is *Sthenoteuthis Bartramii*, known as the "flying squid," because it sometimes shoots out of the water with such force as to fall upon the decks of vessels. Very large specimens of this were caught off Cape Hatteras at the surface, and during the last season (1884) they were taken in large numbers and of large size off Martha's Vineyard by jigging them with hooks after attracting them to the side of the steamer by an electric light lowered to the surface of the water. It was not previously known north of Cape Hatteras. A small squid, furnished with sharp claws on its long arms (*Onychia agilis* V.), was also taken at the surface last summer. Many dead and more or less mutilated examples of the great, gelatinous, Octopus-like *Alloposus mollis* V. were several times observed floating at the surface, and sometimes also large specimens of a curious squid (*Calliteuthis reversa* V.). Both of these are probably true deep-sea species, which only rise to the surface when dead or disabled.

The various pieces of drift timber found floating in the Gulf Stream have always been found filled with the burrows of a large species of *Teredo* (*T. megotara*, fig. 127), which seems to be the only common species in that region.

Among the most abundant forms of pelagic life are several species of *Salpa*. One of these is the common species of the New England coast (*Salpa Caboti*, figs. 147, *a*), which grows to be only about an inch long, in the solitary form, but it often occurs in vast quantities, completely filling the sea, so that surface nets are quickly filled and clogged up with it. In this there are delicate reticulations of clear blue lines on the edges of the mantle, gills, and other internal organs, and the nucleus is usually deeply tinged with blue.

A much larger species, which is also very abundant on most trips, often grows in the solitary form to the length of 3 to 4 inches or more, with a diameter of 1 to 1.25 inches, while the chained individuals are sometimes even longer, with each end running out into a long, tapering, acute tip, while both ends are abruptly terminated in the solitary individuals. The body has eight longitudinal angles or keels, serrated along their edges. The chains often become several feet long, but easily break up when disturbed. This species (figs. 148–150) is related to *S. maxima* Forskal, but is apparently distinct. It is, however, probably identical with *S. clostra*, M. Edwards, of the Mediterranean, well figured in the illustrated edition of Cuvier (Plate 121, figs. 2–2*d*).

In this the whole body is nearly colorless, except the nucleus, which is dull orange or orange-brown, but whitish on the sides. On many occasions a bushel or more of this species has been caught in the trawl, evidently from near the surface. In the summer of 1884, this species was taken in Vineyard Sound and Buzzard's Bay, August 25 to September 5, in considerable numbers, but not so large as those found in the Gulf Stream. This must be an unusual occurrence, however. A special collection of this species was made in 1882, by hardening in chromic acid, to be used by Professor Brooks for making sections in studying its anatomy and embryology, and were found by him very satisfactory.

Another very interesting species (*S. pinnata*), previously known from the Mediterranean, was taken in 1883, off Cape Hatteras. In this species the chained individuals are united together in such a way as to form circular or wreath-like groups. Species of *Doliolum* (fig. 146) and of *Appendicularia* were also taken, but have not been studied with care.

Large specimens of *Pyrosoma* have also been taken on several occasions. Some of these were 15 to 18 inches long, and nearly 2 inches in diameter at the larger end, tapering gradually to the small end.

The floating masses of sea-weeds (*Sargassum* and *Fucus*) are nearly always covered with various species of Hydroids and Bryozoa. Among the latter is an encrusting species which covers the fronds and bladders with a delicate calcareous network, and when the *Sargassum* is dried

the bladders often shrink away and leave the encrusting Bryozoa in the form of very elegant hollow balls. Among the Hydroids the most abundant are *Obelia geniculata* and several small species of *Aglaophenia*.

The jelly fishes are very abundant and very interesting in the Gulf Stream water. Among the most common and conspicuous is the "Portuguese man-of-war" (*Physalia arethusa*), remarkable for its curious form and habits, as well as for its brilliant blue and crimson colors and its virulent stinging powers. Related to this, and not less beautiful, is the *Porpita Linnæana*, which has a very beautiful, circular, radiated, pinkish floating disk, bordered with bright blue, while the delicate zooids hanging from its lower surface form an elegant blue and green fringe around it. This has been taken several times, but the best lot was obtained at station 2039. Specimens of the allied form (*Velella mutica*), which is beautifully varied with blue, green, and pink, and has a thin oblong disk, with an oblique, diagonal crest or sail, were taken, but they were not full grown. Several other species of Siphonophores were obtained, among which were *Gleba hippopus* and a species of *Cuboides*. Of the medusæ, *Pelagia cyanella*, *Stomolophus meleagris*, *Periphylla hyacinthina*, *Trachynema digitale*, *Calycopsis typa* Fewkes, and a large species of *Zygodactyla* were among the most prominent.

A large and conspicuous medusa, with distant, stout, and rather stiff-looking tentacles, and broad, deep marginal lobes, was taken in several localities. (Stations 2034, 2037, 2039, 2040, 2045, 2079, 2104.) It grows to be over 6 inches in diameter, and the stomach and genital organs have a deep purplish brown color when recently placed in alcohol, but its color in life was not noted. Mr. Fewkes considers this a new species of the rare genus, *Atolla* (*A. Verrillii*). The specimens of *Stomolophus meleagris* were large and handsome. According to the observations of Mr. William Nye, jr., on the "Albatross," the disk in this species contracted, when first taken, 102 times per minute. It was taken near stations 2085 and 2088.

Among the most abundant and characteristic of the forms of pelagic life are the curious, transparent-finned worms belonging to the genus *Sagitta* (figs. 196, *a*). These have a well-marked head with two eyes, and with broad groups of sharp, curved spines on each side of the head, while there is a well-developed caudal fin, like that of a fish in form, and other fins on the sides of the body. They swim through the water with great rapidity and are so transparent that they are not easily seen. They are usually taken in large numbers in our surface nets, of all sizes, from a small fraction of an inch up to 2 or 3 inches in length. Probably there are several species among them. They are equally abundant in the trawl-wings from all depths, and among those that have been taken only in the trawl-wings there is one large species, nearly 3 inches long, which is deep salmon or orange in color, while the surface species are colorless.

A very different but equally transparent worm (*Tomopteris*) is also frequently taken. In this genus there are bilobed swimming-feet along

each side, with a pair of long curved appendages on the sides of the head. Some singular forms of Turbellarian worms have also been taken, one of which is about 2 inches long, and flat, with a pair of long lateral appendages extending back from the head. Its color in life was orange.

The Protozoa are also well represented by various species of Radiolaria and Foraminifera. Among the latter are several small species of *Globigerina* and allied genera that are nearly always taken in the surface nets, and the shells of these are also among the most abundant of those that constitute the "Globigerina ooze" of the bottom.

It is certain that all this vast assemblage of surface-life must be constantly dying and sinking to the bottom, thus furnishing food for the numerous inhabitants of the deep sea, directly or indirectly. Although these soft-bodied creatures would quickly decay in water so warm as the surface of the Gulf Stream, it is necessary to remember that at the depth of less than 150 fathoms the temperature falls to about 40° F., so that decomposition would go on very slowly after they had fallen to that depth. However, it is probable that such creatures begin to sink into the cold depths as soon as they are injured or weakened in any way, and thus they would reach the cold zone before life is extinct. In fact it may be that the cold itself in most cases is the actual or immediate cause of the death of those weakened or partially disabled creatures that are unable to keep their places at the surface. As a matter of fact, I have taken from the stomachs of bottom-dwelling creatures, like Actiniæ and star-fishes, various surface animals, including *Salpa* and *Lepas*, which showed no signs of decomposition. Yet it is estimated that it would take several days for such things to sink to the bottom in 2,000 fathoms.

Hitherto we have not met with small forms of plant life in the Gulf Stream in any abundance. The microscopic plant life seems to be much less abundant there than near the coast. In fact, the small amount of such organisms hitherto observed seems to indicate that the vast numbers of the small forms of animal life cannot depend mainly upon plants for their primary food-supply, and renders it more than probable that many of the Protozoa, at least, are capable of deriving their food directly from inorganic matter to a large extent, if not entirely. It is not necessary to believe that this power is restricted to the vegetable kingdom, but this question needs farther investigation.

PRELIMINARY LIST OF ACALEPHÆ COLLECTED BY THE "ALBATROSS" IN 1883 *IN THE REGION OF THE GULF STREAM.*

By J. W. Fewkes.

The following list includes nearly all the species obtained in 1883, with the exception of various minute hydroid gonophores, which have not yet been studied, and a few species too imperfectly preserved for

identification. A few species obtained in 1884 are also included in the list.*

Atolla Verrillii Fewkes, sp. nov.

The genus *Atolla* was described by Hæckel in his report on the deep-sea medusæ of the "Challenger," from the Antarctic Ocean, between the Kerguelen Islands and Melbourne, and from St. Mathias Bay, Patagonia.

Our species was collected in the following localities:

Station.	Locality— N. lat.	W. long.	Depth.
	° ′ ″	° ′ ″	Fathoms.
2034	39 27 10	69 56 20	1,346
2037	38 53 00	69 23 30	1,731
2039	38 19 26	68 20 20	2,369
2040	38 35 13	68 16 00	2,226
2042	39 33 00	68 26 45	1,555
2044	40 00 50	68 37 20	1,067
2045	40 04 20	68 43 50	373
2094	39 44 30	71 04 00	1,022

The genus is represented by eight specimens, three of which are over 45mm in diameter. The "Challenger" collected five specimens. Our species is very closely related to the Antarctic one, *A. Wyvillii* Hæck. The depth recorded for *A. Wyvillii* is 1,950 and 2,040 fathoms. Our species ranges from 373 to 2,369 fathoms. My largest specimen, a little over 45mm in diameter, although smaller than Hæckel's largest (66mm) has twenty eight tentacles, marginal sense-bodies, and marginal lobes before bifurcation, while his has but twenty-two.

Nauphantopsis Diomedeæ, gen. et sp. nov.

A new genus, *Nauphantopsis*, one of the most important collected by the "Albatross," resembles *Nauphanta* in the sculpturing of the exumbrella, but while the latter has sixteen marginal lappets, *Nauphantopsis* has thirty-two; *Nauphantopsis* has thirty-two deep furrows across the corona; *Nauphanta* has sixteen deep and sixteen shallow coronal incisions; *Nauphantopsis* has twenty-four tentacles and eight sense-bodies, which are very imperfect. *Nauphanta* has eight tentacles and eight sense-bodies. Three tentacles are therefore side by side on the rim of the former, alternating with the sense-bodies. The single specimen was found at station 2038, in latitude 38° 30′ 30″ N. and longitude 69° 08′ 25″ W., in a depth of 2,033 fathoms.

This genus is morphologically one of the most valuable of the collection, and, like *Nauphanta*, probably belongs to the deep-sea fauna. It connects the family of Collaspidæ, of which *Atolla* is one of two mem-

* In most cases it is impossible to say whether the novel forms of medusæ taken in the trawl and trawl-wings are inhabitants of the bottom waters or the surface, or of intermediate depths. Eventually those that belong to the surface-fauna will doubtless be taken in the surface-nets, but this will require much more extensive collecting of the surface animals than has yet been attempted.

A. E. V.

bers, with the Periphyllidæ. Its coronal furrow and sculpturing of the exumbrella recalls the former family, and the arrangement of the tentacles in threes and other features, the latter. Hæckel rightly says of *Nauphanta* that, like *Atolla*, "it is a true deep-sea form of high phylogenetic antiquity." The allied *Nauphantopsis* supports Hæckel's interpretation of the relationship of the Peromedusæ and the Collaspidæ.

Ephyroides rotaformis Fewkes, gen. et sp. nov.

A new genus, *Ephyroides*, has rounded elevations, from sixteen to thirty-two in number, on the exumbral side of the corona of the bell. It is a member of the Ephyridæ of Hæckel, and occurs at the following stations:

Station.	Locality— N. lat.	Locality— W. long.	Depth.
	° ′ ″	° ′ ″	*Fathoms.*
2042	39 33 00	68 26 45	1,555
2044	40 00 30	68 37 20	1,067
2051	39 41 00	69 20 20	1,106
2047	40 02 30	68 49 40	389

Periphylla hyacinthina Steenstrup.

The Periphyllidæ are represented by a fine suite of specimens of the medusa, *Periphylla hyacinthina* Steenstrup, and another species which may turn out to be a new genus closely allied to the latter. From these medusæ, of which there are fifteen specimens, I shall be able to study at length the development of the genus *Periphylla*, of which at present nothing is known.

Halicreas minimum Fewkes.

In 1880-'81 the "Albatross" collected a strange medusa, to which was given (Bull. Mus. Comp. Zool., vol. ix, No. 8) the name *Halicreas minimum* Fewkes. In the present collection this genus is represented by several specimens. The genus is a marked one, by the possession of eight prominences on the margin of the umbrella, from which radial ribs extend toward the center of the disk. These radial prominences bear two or more rows of small rounded tubercles. The velum is similar to that of *Solmaris*, *Cunina* and certain Narcomedusæ. It has eight rounded knobs on the subumbral surface of the disk, as in the young *Zygodactyla Grœnlandica*. The specimens of this genus in the collection will enable me to make out a good anatomy of this extraordinary medusa. They come from the following stations:

Station.	Locality— N. lat.	Locality— W. long.	Depth.
	° ′ ″	° ′ ″	*Fathoms.*
2034	39 27 10	69 56 20	1,346
2036	38 52 40	69 24 40	1,735
2039	38 19 26	68 20 20	2,369
2041	39 22 50	68 25 00	1,608
2042	39 33 00	68 26 45	1,555
2216	39 47 00	70 30 30	963

Halicreas is the type of a new family of medusæ, the Halicreasidæ, which stands intermediate between the Narcomedusæ and the Acraspeda.

Among the smaller medusæ there are many Campanellidæ.

Solmaris incisa, sp. nov.

A giant *Solmaris* (50–60^{mm} in diameter) of a new species (*S. incisa*) is represented by three specimens from the following stations:

Station.	Locality— N. lat.	Locality— W. long.	Depth.
	° ′ ″	° ′ ″	Fathoms.
2094	39 44 30	71 04 00	1,022
2104	38 48 00	72 40 30	991

This species has thirty-two radial pits or furrows on the subumbral side of the disk. These indentations are confined to the corona.

HYDROIDA.

The hydroid gonophores are very numerous, and there are species of *Zygodactyla*, sp. nov., and *Mesonema*, *Staurophora laciniata* Ag., *Turris episcopalis* Fewkes, several Oceanidæ, and one or two minute genera which have not been satisfactorily examined.

The collection also contains specimens of *Porpita Linnæana* Less., *Velella mutica* Bosc, and *Rataria* (young *Velella?*). There is a single *Agalma* nectocalyx, a large *Gleba*, and fragments of Agalmidæ. *Cuboides* and *Sphenoides* were found for the first time in the Gulf Stream.

The indications are that there are several genera and species of Rhizophysidæ in the Gulf Stream. The collection contains fragments of three or four undetermined species, besides two species which could be identified. There is also a new genus of Rhizophysidæ in the collection. A new species of *Rhizophysa* is allied to *R. inermis* of Studer. In this species there are no tentacles, and the polypites and sexual organs arise in clusters at intervals on the axis, as in *Apolemia*. The float of another unknown *Rhizophysa* is 15^{mm} in shorter, 30^{mm} in longer diameter, *in alcohol*. This is the largest *Rhizophysa* float ever recorded. A short section of the stem of this giant still remains with the float, but the remainder, with its appendages, is broken and lost, so that identification is impossible.

Pterophysa grandis, gen. et sp. nov.

A magnificent new genus of Rhizophysidæ, which will be described under the name *Pterophysa*, is one of the most important additions made by the "Albatross" to our Medusan fauna. This genus has two lateral muscular wings on the polypites and no tentacles. The sides of the polypites are specialized into grasping organs, which, in conjunction with the lateral folds, convert these organs into suckers, by which

the animal clings to a foreign body. This specialization may also serve for the capture of prey, since *Pterophysa* has no tentacles for that purpose. The genus was found clinging to the "dredge rope" at station 2227. Collected in 1884.

Angelopsis globosa, gen. et sp. nov.

Lesson, in his "Histoire des Zoophytes Acalephes," figures and describes an interesting medusa, discovered by Rang, to which he gave the name *Angela*. This genus lies between *Physalia* and other Physophores, and, filling that gap, is of greatest interest. Unfortunately, since the original description by Lesson, *Angela* has never been rediscovered. The collection of the "Albatross" contains a Physophore closely allied to *Angela*, to which the name *Angelopsis* seems appropriate. There are two specimens of *Angelopsis* from station 2105, in latitude 37° 50′ 00″, N., longitude 73° 03′ 50″ W., in a depth of 1,395 fathoms. *Angelopsis* is intermediate in structure between *Rhizophysa* and *Physalia*, and in my judgment shows that Dr. Chun is right in separating these genera from the other Physophores with which they have so little in common.

Pelagia cyanella Per. et Less., *Stomolophus meleagris* Ag., *Aurelia flavidula* Per. et Les., and an unknown Aurelian are found in the collection. There are two specimens of the latter, which is probably a new genus.

In this brief enumeration I have simply made mention or touched upon the salient features of my new genera, without entering upon the many morphological considerations which such unusual forms suggest. I have not enumerated the new species of hydroid gonophores, since at this stage of my research it would be impossible for me to rightly estimate, in the case of most of them, whether their characters are generic or specific. From the nature of the case these small, almost microscopic, medusæ require a longer time for identification. The whole collection confirms a fact which every student of marine zoology who has collected in the Gulf Stream has long known, that these waters teem with a medusan life, of which only a small fraction has yet been described.

The following list contains the majority of the Medusæ sent to me. Several doubtful species are omitted. The majority of the latter are hydroid gonophores of small size and doubtful affinities.

ACRASPEDA.

Atolla Verrillii, sp. nov.
Aurelia flavidula Per. et Less.
Ephyroides rotaformis, gen. et sp. nov.
Nauphantopsis Diomedeæ, gen. et sp. nov.
Periphylla hyacinthina Steenstrup.
Periphylla, sp. nov., forsitan gen. nov.
Stomolophus meleagris Ag.
Aurelia, incertæ sedis.

TRACHYMEDUSÆ.

Campanella, sp. nov.
Halicreas minimum Fewkes.
Solmaris incisa, sp. nov.

SIPHONOPHORA.

Physalia Arethusa Til. Common.
Rhizophysa uvaria, sp. nov.
Rhizophysa, sp.?
Pterophysa grandis, gen. et sp. nov.
Angelopsis globosa, gen. et sp. nov.
Agalma, sp.?
Cuboides, sp.?
Sphenoides, sp.?
Gleba hippopus Forsk.

DISCOIDEA.

Porpita Linnæana Less.
Rataria (*Velella* young?).
Velella mutica Bosc.

HYDROIDA.

Mesonema, sp. nov.
Zygodactyla, sp. nov. Common.
Zygodactyla, sp. nov.
Turris episcopalis Fewkes.
Staurophora laciniata Ag.
Oceanidæ, incertæ sedis.

LIST OF ADDITIONAL GULF STREAM ACALEPHS COLLECTED IN 1880 *AND* 1881.

The following species were recorded by Mr. Fewkes in his former paper:*

CTENOPHORA.

Beroë, sp.
Station 920, 1881.

DISCOPHORA.

Periphylla hyacinthina Steenstrup.
Stations 936, 952, 954, 995, 1881.

SIPHONOPHORA.

Apolemia, sp.
Off Block Island, 1880.

* On the Acalephæ of the east coast of New England; II Acalephæ collected by the United States Fish Commission during the summer of 1880 and 1881. (Bulletin Museum Comp. Zool., vol. ix, p. 300, 1880.)

Agalma elegans Fewkes.
Gulf Stream, 1880.

Haliphyta magnifica Fewkes.
Station 953, 1881.

Diphyes, sp.
Gulf Stream, 1880.

HYDROIDA.

Trachynema digitale A. Ag.
Stations 985, 1026, 1881.

Calycopsis typa Fewkes.
Station 870, 1880; and stations 924, 945, 952, 1881.

Chromatonema rubrum Fewkes.
Stations 936, 954, 1881.

Halicreas minimum Fewkes.
Stations 954, 1029, 1881.

EXPLANATION OF PLATES.

Unless otherwise stated, the figures on all the plates were made by Mr. J. H. Emerton.

PLATE I.

FIG. 1. *Umbellula Bairdii* V. Side view of the polyps and upper part of the stem, natural size; 1*a*, lower end of the stem and bulb of the same.

FIG. 2. The same. Ventral view, showing the tentacles in partial retraction.

FIG. 3. *Umbellula Guntheri* K. Ventral view of the polyps and upper part of the stem, natural size.

FIG. 3 *a*. The same. Dorsal view.

FIG. 3 *b*. The same. Lower end of the stem and bulb.

1

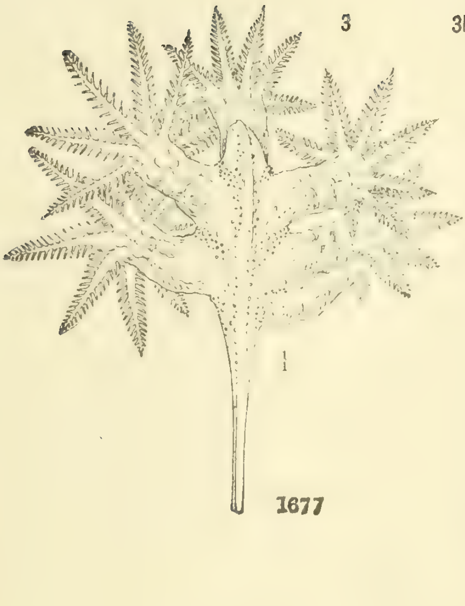
1a

1675

2

1676

3



1677

3b

3a

1678

Plate II.

FIG. 4. *Benthoptilum sertum* V. Ventral view of a part of the rachis, showing one of the middle clusters of polyps entire and the base of the opposite cluster, natural size.

FIG. 10. *Lepidogargia gracilis* V. Side view of a portion of the stem, showing two of the polyps, enlarged four diameters.

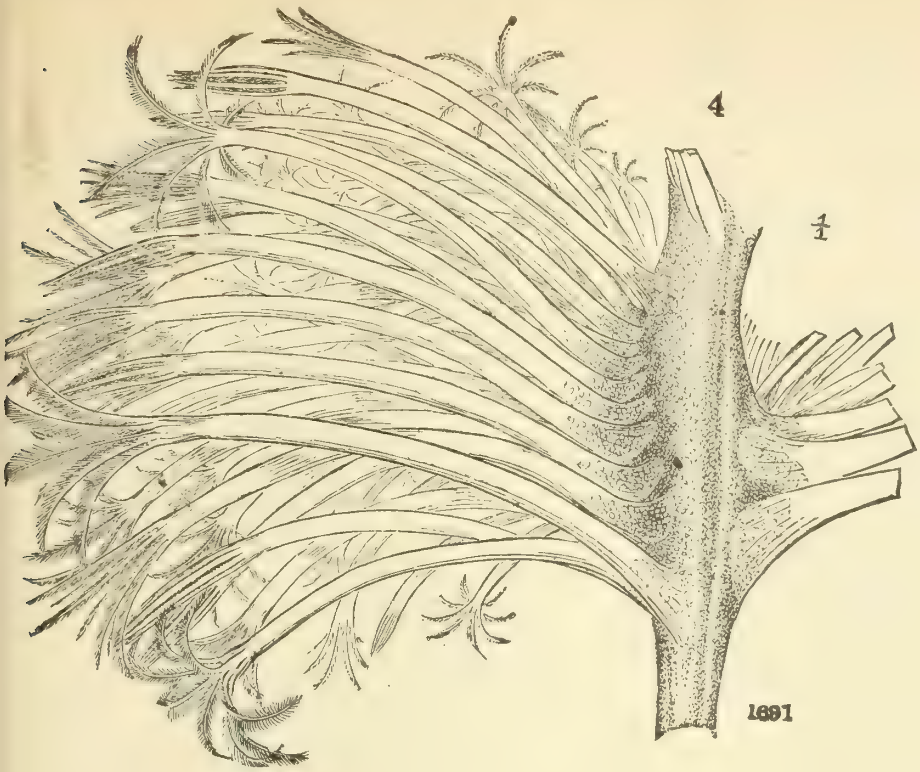
FIG. 10*a*. The same. Showing the base of the denuded stem and a part of the branched roots, natural size. The terminal branchlets of the roots have been broken off from this specimen.

FIG. 12. *Anthomastus grandiflorus* V. Side view of a small specimen, showing the expanded polyps and the branched or lobulated roots, characteristic of specimens taken on muddy bottoms, natural size.

FIG. 13. *Gersemia longiflora* V. Side view of a rather small specimen, with the base attached to a joint of *Lepidisis caryophyllia*, and forming a bulbous expansion filled with mud below it, enlarged one and one-half diameters.

PLATE II.

4



$\frac{1}{1}$

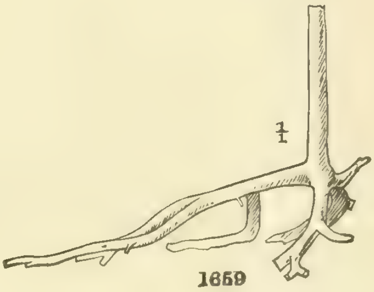
1691

10

×4

1658

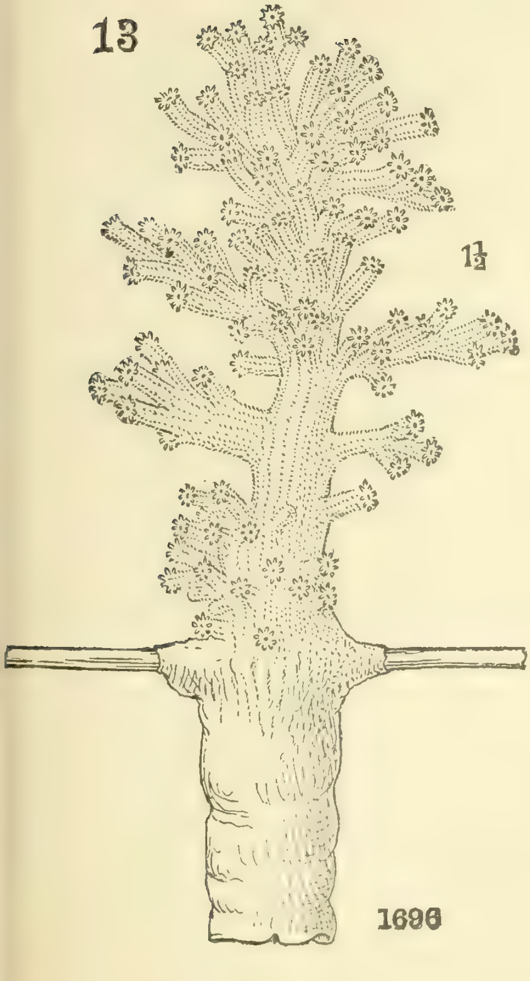
10 *a*



$\frac{1}{1}$

1659

13



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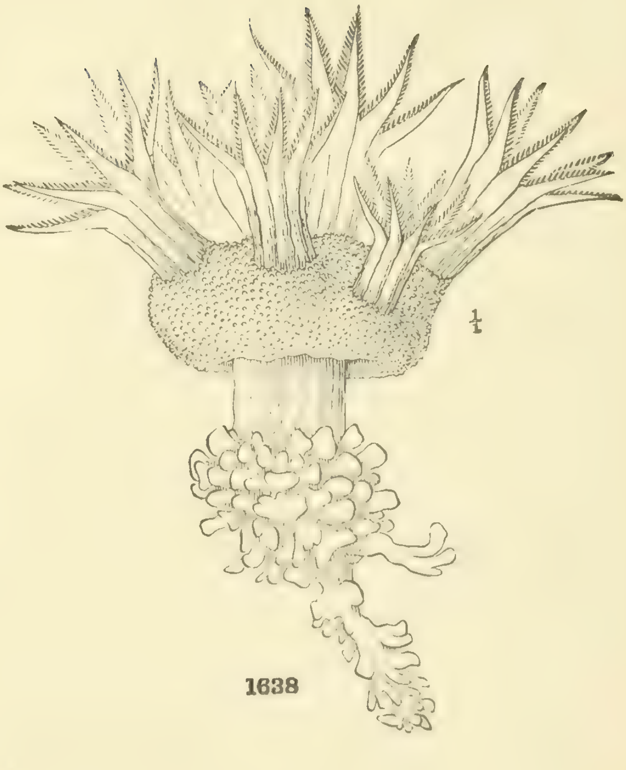

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1638

PLATE III.

FIG. 5. *Kophobelemnon tenue* V. Ventral view, natural size.

FIG. 5 *a*. The same. Dorsal view.

FIG. 6. *Scleroptilum gracile* V. Dorsal view of a small specimen, enlarged one and one-half diameters.

FIG. 7. *Pennatula aculeata*. Ventral view of a medium sized specimen, natural size; *a*, dorsal view of a young specimen, drawn from life, showing the expanded polyps, one-half natural size; *b*, front view of one of the polyps of the same, much enlarged.

FIG. 11. *Balticina Finmarchica*. Side view of a small specimen, imperfect at the summit, one-half natural size.

FIG. 11 *a*. The same. Side view of a portion from the middle part of the rachis, somewhat enlarged.

FIG. 11 *b*. The same. One of the calicles and expanded polyps (*a*), enlarged nine diameters.

FIG. 201. *Lepidisis caryophyllia* V. Portion of the middle part of the stem bearing three polyps, enlarged four diameters; *c*, a group of the external scale-like spicula of the cœnenchyma, enlarged sixty diameters.

PLATE III.

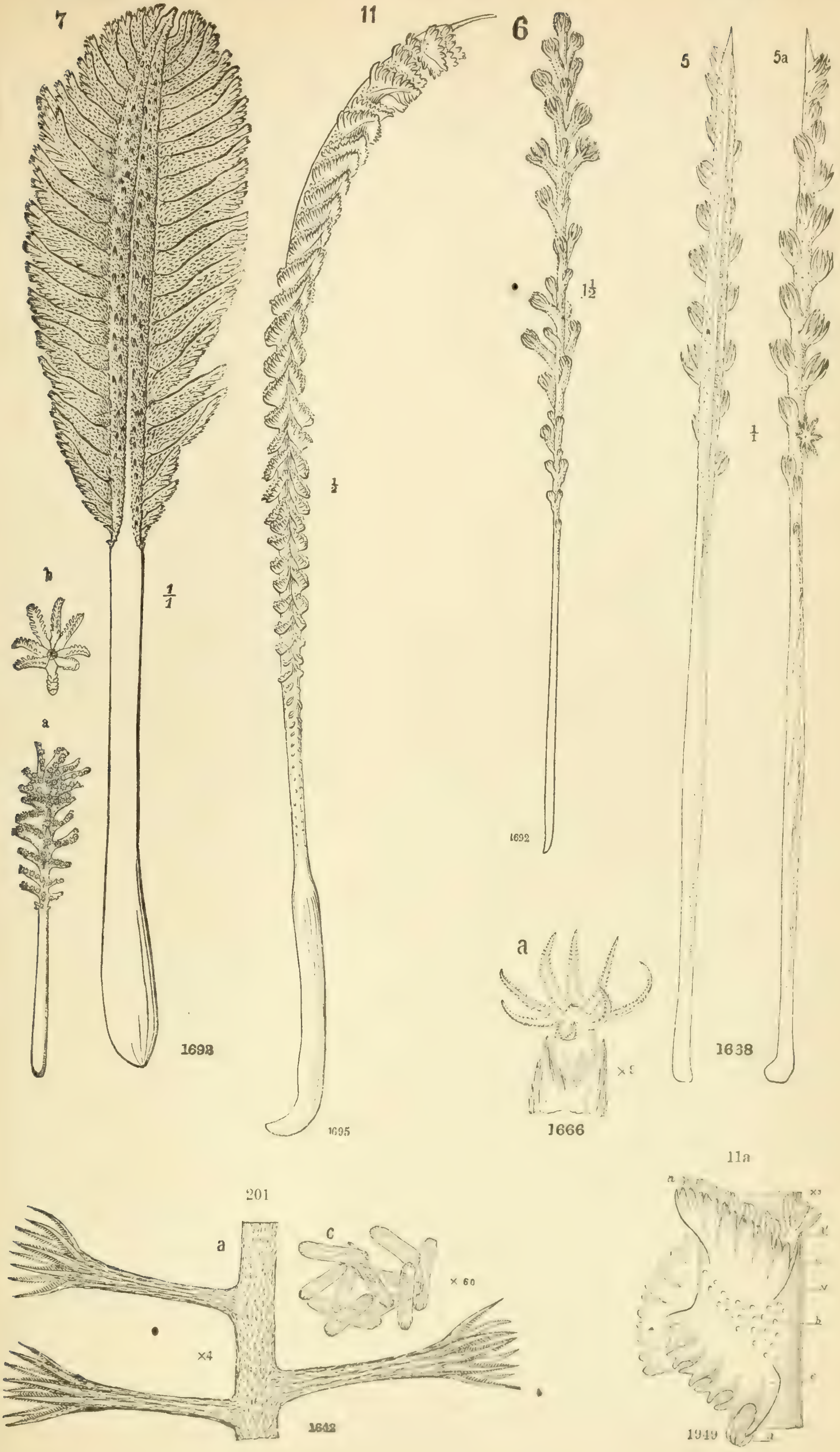

7
11
6
5
5a
b
a
1/1
1/2
1 1/2
1/1
1693
1695
1692
a
1666
1638
201
a
c
× 60
×4
1642
11a
1949

PLATE IV.

FIG. 8. *Pennatula (Ptilella) borealis.* Side view of a rather small specimen, one-half natural size.

FIG. 8 *a.* The same. Side view of a part of the rachis and pinnæ, enlarged two diameters; *a*, the pinnæ with full-sized sexual polyps; *a′*, rudimentary pinnæ at the base of the rachis; *b*, the lateral groups of the rudimentary or asexual zoöids; *b′*, clusters of similar zoöids on the basal part of the pinnæ; *b″*, the larger asexual zoöids along the ventral surface of the rachis; *e*, the naked area at the base of the pinnæ; *e′*, *ee″*, the naked surfaces on the upper and lower surfaces of the pinnæ near the base; *v*, the naked longitudinal area on the ventral side of the rachis; P, the basal bulb; P′, the enlarged swelling at the upper end of the bulb.

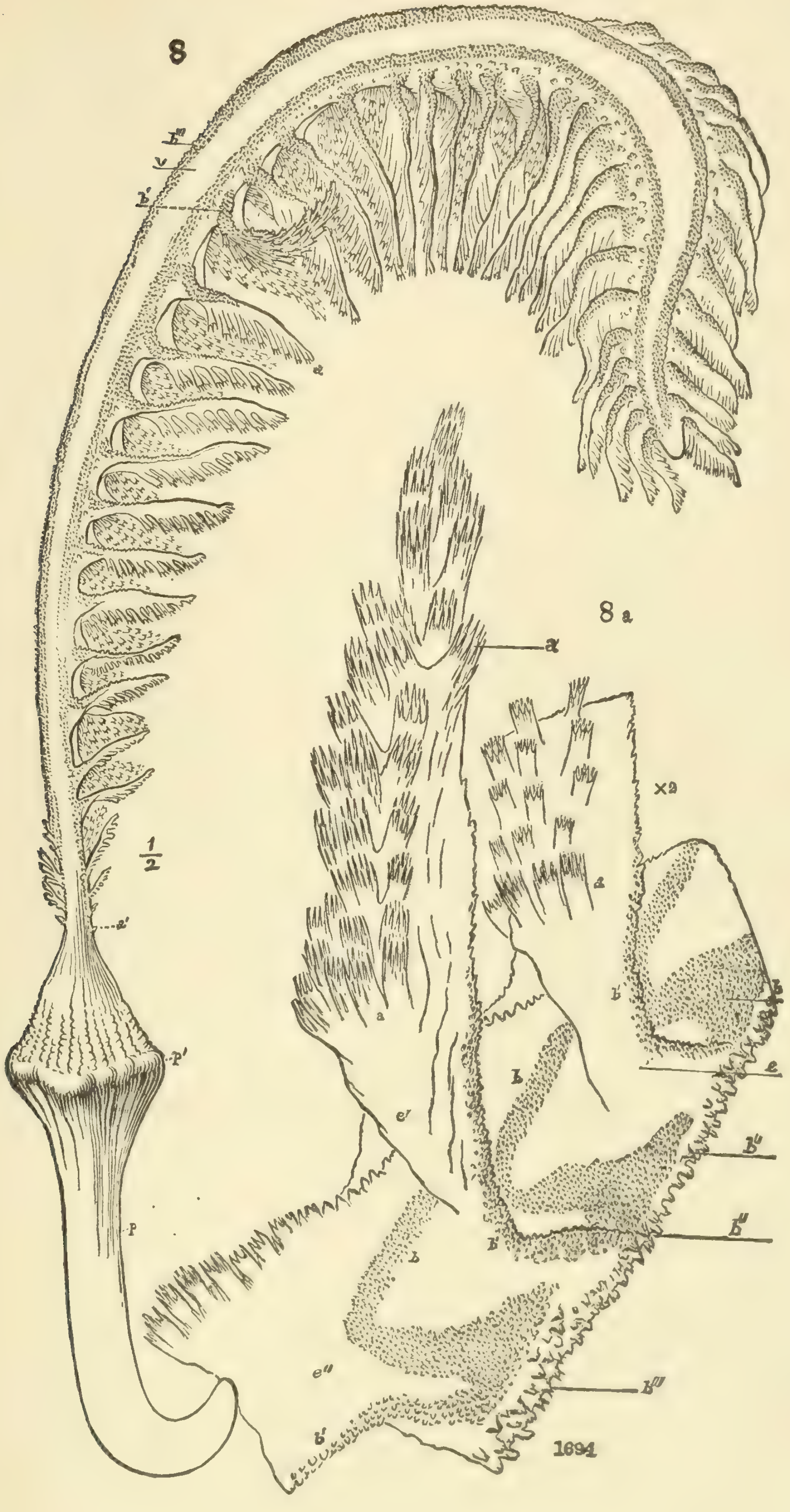

8
8 a
1/2
×2
1694

PLATE V.

FIG. 14. *Flabellum Goodei* V. Top view of a medium-sized specimen, showing the animal in partial contraction, enlarged one and one-half diameters. From a specimen recently preserved in alcohol.

FIG. 15. *Flabellum angulatum.* Side view, enlarged one and one-half diameters.

FIG. 16. *Caryophyllia communis.* Side view, enlarged one and one-half diameters.

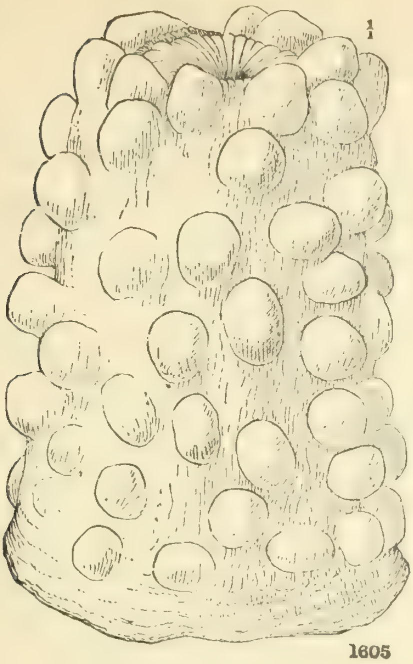
FIG. 17. *Dasmosmilia Lymani*, one and one-half natural size. Side view of a specimen from which about one-fourth had been broken away by a longitudinal fracture, after which the calicle had been perfectly restored.

FIG. 20. *Actinauge nodosa.* Side view of a specimen in partial expansion, with a bulbous base inclosing mud, one-half natural size.

FIG. 20 *a.* *Actinauge nodosa,* variety *tuberculosa.* Side view of a contracted specimen, natural size.

Figs. 15, 16, 17, were drawn by Mr. J. H. Blake, and the others by Mr. J. H. Emerton.

20 *a*



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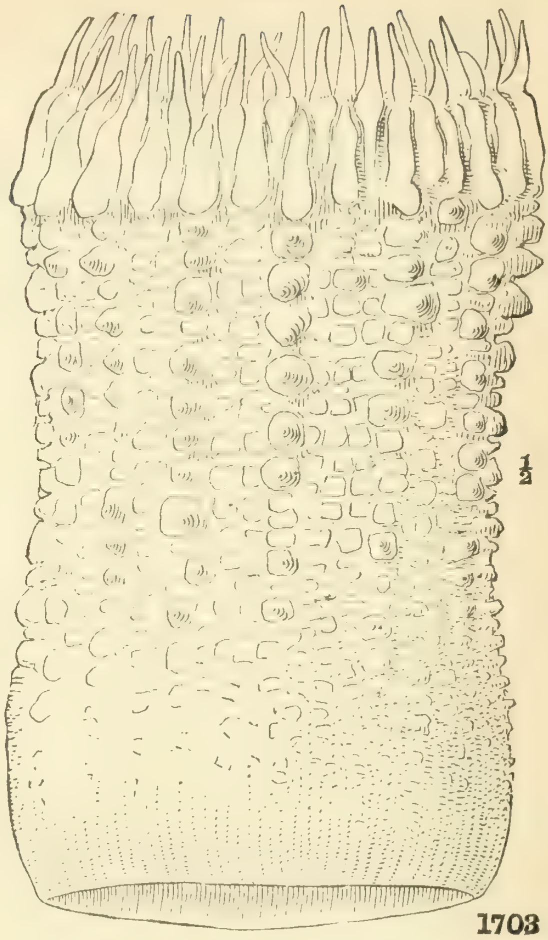

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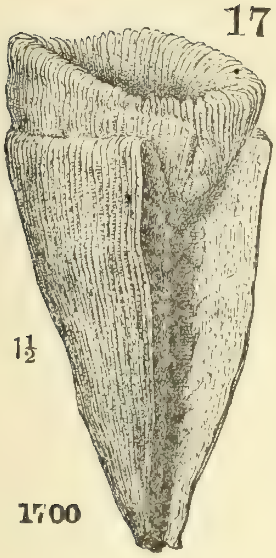
1703

17



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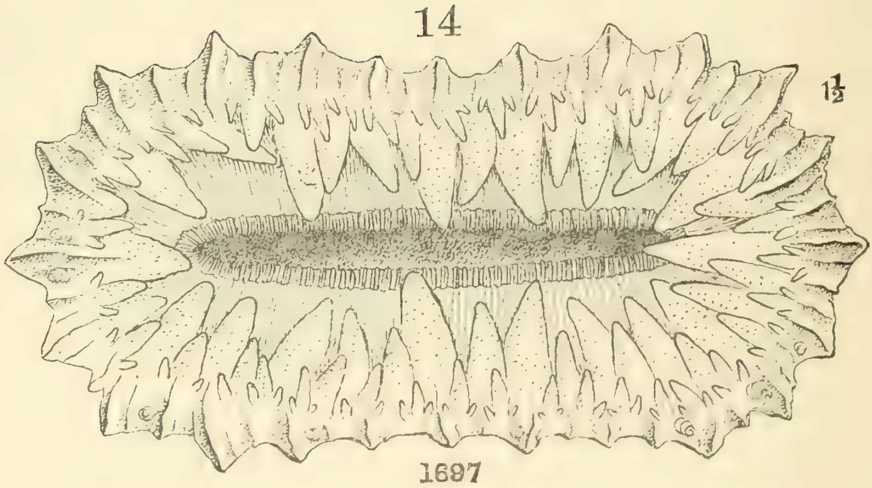

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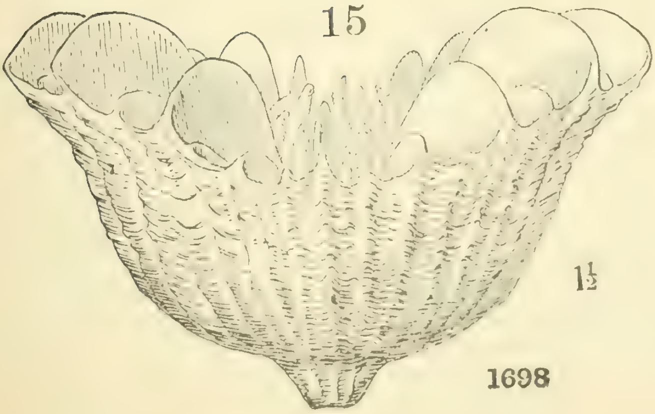

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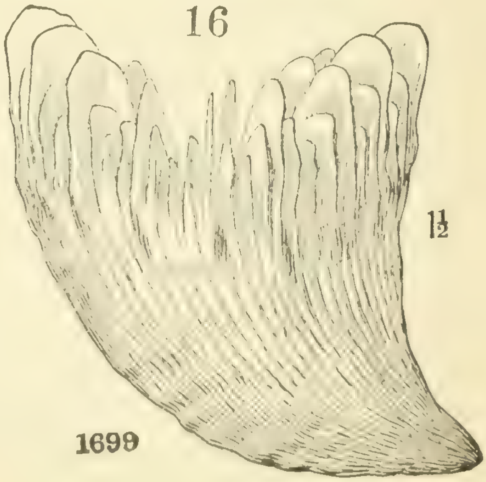

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PLATE VI.

FIG. 19. *Urticina perdix* V. Side view of a living specimen in partial expansion, one-half natural size; *a*, the same, top view of the mouth and a segment of the disk, showing the arrangement of the tentacles, natural size.

FIG. 19 *b*. The same. Side view of a large, living specimen in full expansion, with the border of the disk broadly extended and thrown into undulations or frills and with the mouth protruded at the summit of a cone, less than one-half natural size.

FIG. 27. *Epizoanthus abyssorum* V. Dorsal view of a group forming the carcinœcium of *Parapagurus pilosimanus*, natural size.

FIG. 27 *a*. The same. Side view of a small cluster arising from a grain of sand, natural size.

27 a

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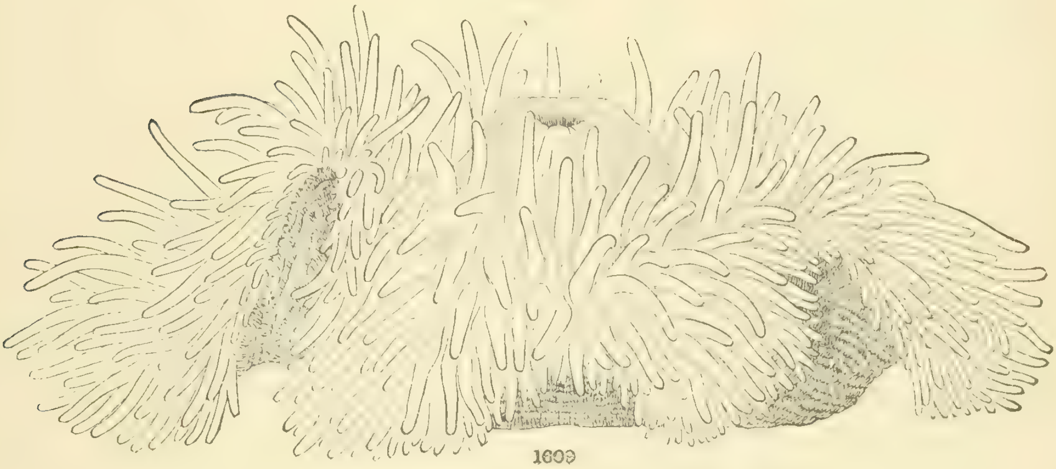
27

$\frac{1}{4}$

1623

19 b



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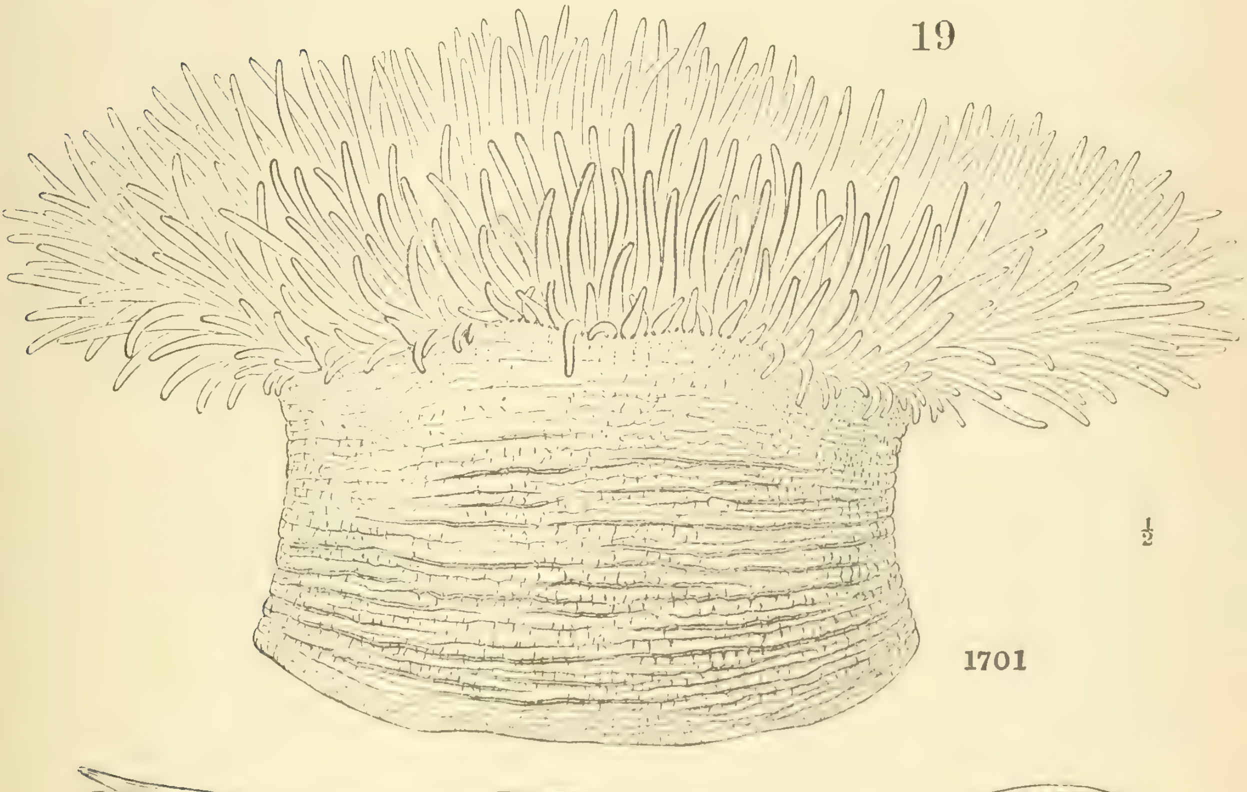


$\frac{1}{2}$

1701

a

$\frac{1}{1}$

1702

PLATE VII.

FIG. 21. *Actinauge longicornis* V. Side view of a medium-sized living specimen in partial expansion, about one-half natural size. The dotted line shows the form and extent of the cavity containing mud in the bulbous base.

FIG. 22. *Actinauge nexilis* V. Top view of a partially expanded specimen attached to the summit of the denuded axis of *Balticina Finmarchica*, somewhat enlarged.

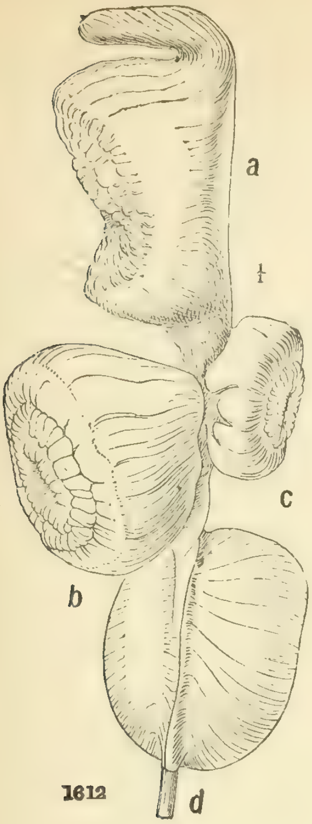
FIG. 22 *a*. The same. A group of four individuals attached in the same way and completely covering the axis by the clasping bases, natural size; *a*, side view of the terminal individual closely contracted; *b* and *c*, two smaller individuals less contracted; *d*, basal view of a similar individual showing the suture of the clasping base.

FIG. 23. *Actinernus nobilis* V. View of the expanded disk and tentacles, two-thirds natural size.

FIG. 23 *a*. Side view of a smaller and more contracted specimen, two-thirds natural size.

FIG. 200. *Sagartia spongicola* V. Top view of a small specimen clasping a stem of *Tubularia*, natural size.

22 a



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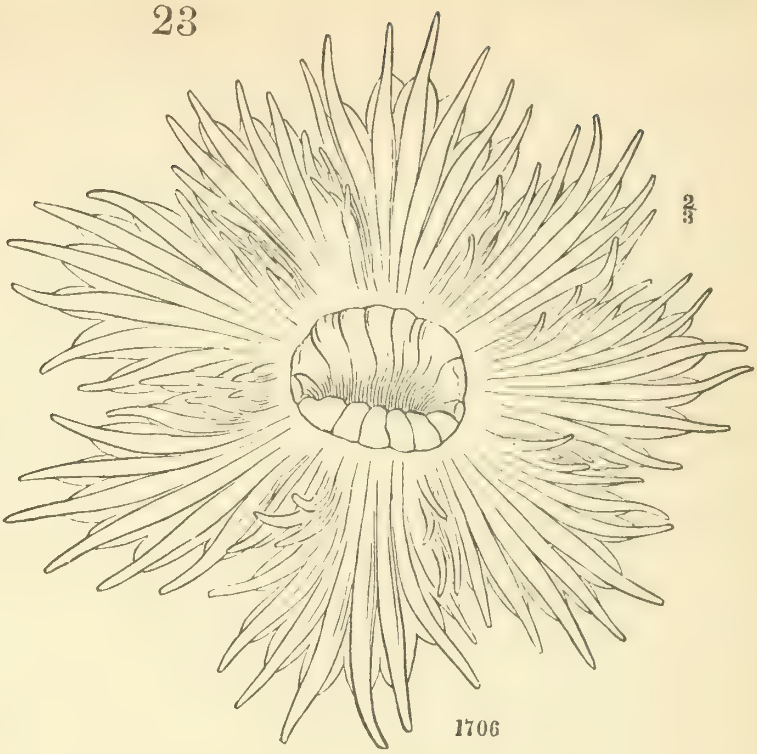

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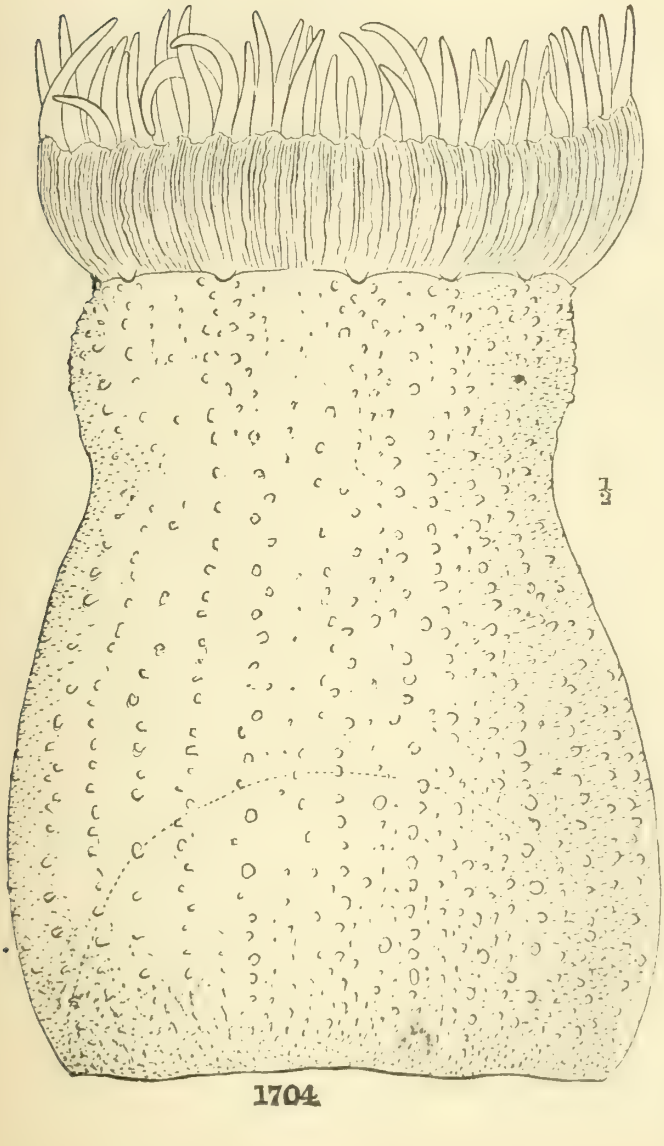

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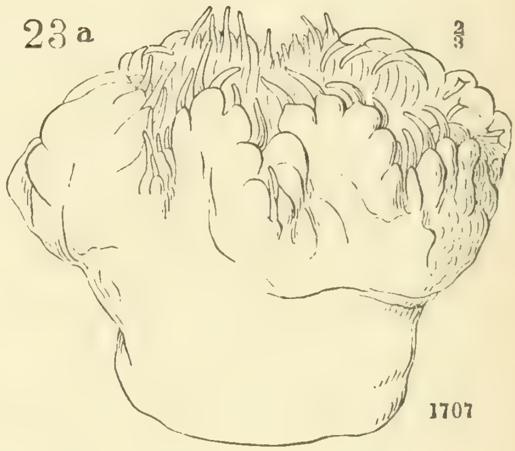
23 a



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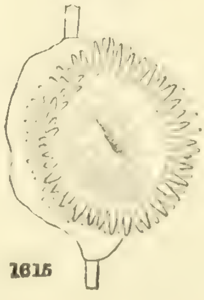

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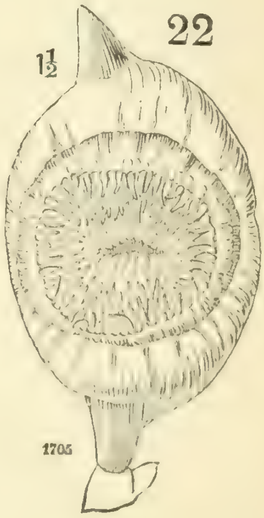
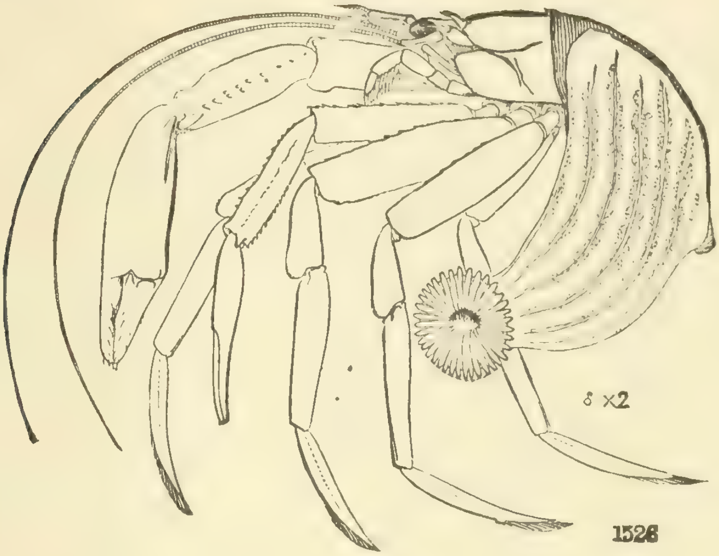


PLATE VIII.

FIG. 26. *Adamsia sociabilis* V., forming the carcinœcium of *Catapagurus Sharreri*, side view of the male, enlarged two diameters.

FIG. 28. *Epizoanthus paguriphilus* V., forming the carcinœcium of *Parapagurus pilosimanus* Smith, about three-fifths natural size. From an alcoholic specimen in which some of the polyps were partially expanded.

26



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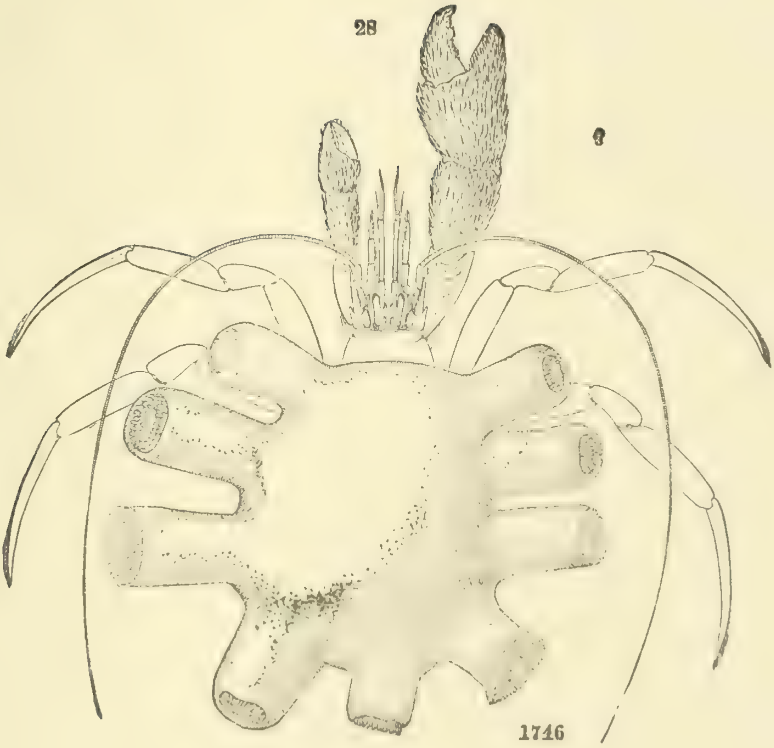

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PLATE IX.

FIG. 9. *Anthoptilum grandiflorum* V. Dorsal view of four clusters of polyps from the middle portion of the rachis and of the groups of rudimentary zoöids between their bases, natural size. On the lower part of the figure some of the polyps have been cut off to show their arrangement. Drawn from an alcoholic specimen.

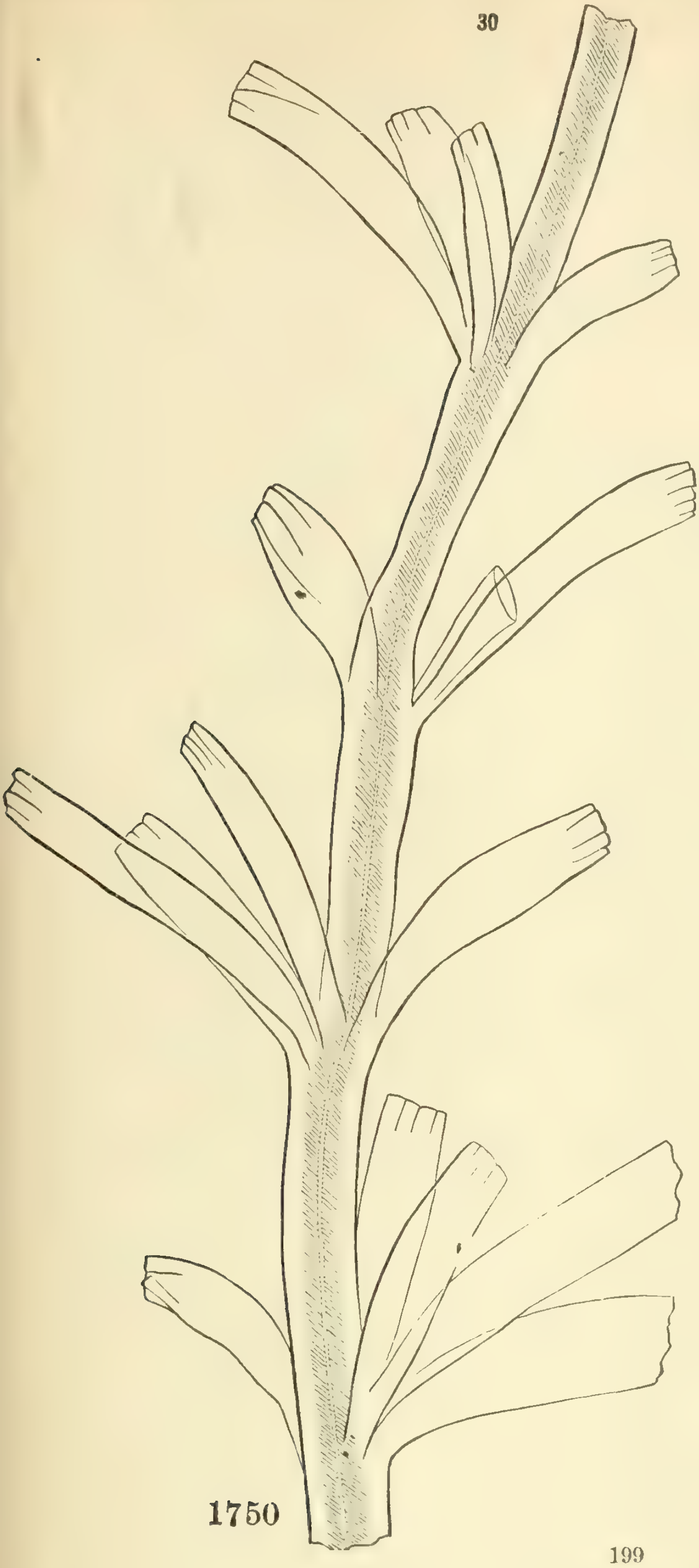
FIG. 9*a*. The same. Side view, natural size.

FIG. 29. *Cladocarpus flexilis* V. Side view of a portion of a branch showing the form of the calicles and nematophores, enlarged twenty diameters.

FIG. 30. *Calicella plicatilis*. View of a branch, enlarged twenty diameters.

FIG. 199. *Dasygorgia Agassizii* V. Part of the stem and one branch of the type specimen from the "Blake" Expedition.

30



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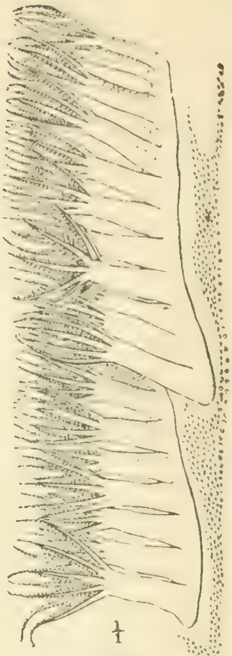
9 a



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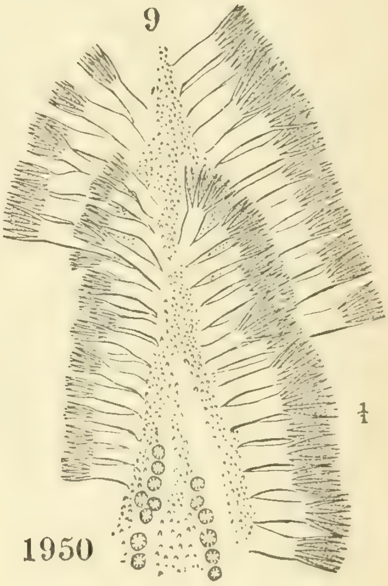

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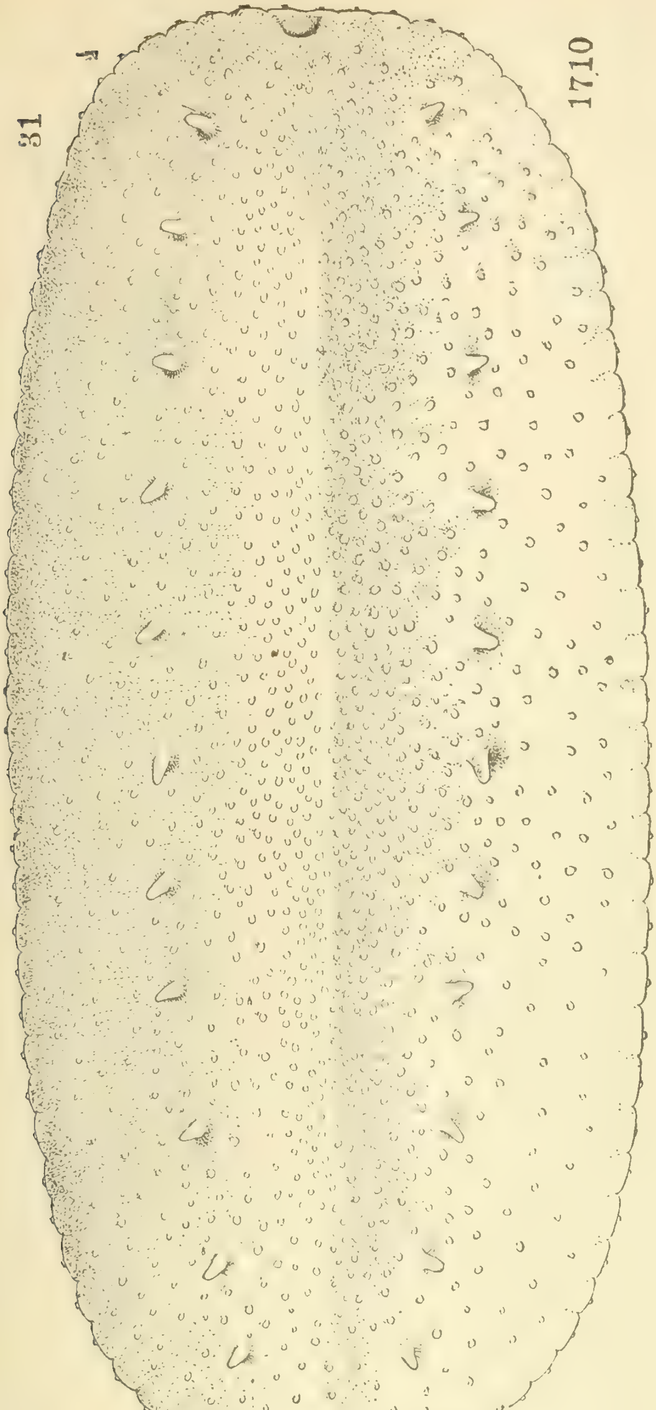
PLATE X.

FIG. 31. *Benthodytes gigantea* V. Dorsal view of a rather small specimen, one-half natural size. From a specimen kept a short time in alcohol.

FIG. 32. *Euphronides cornuta* V. Side view of a small-sized specimen, two-thirds natural size. Copied from a sketch made from a living specimen by Mr. A. Baldwin.

FIG. 34. *Lophothuria Fabricii* V. Upper and under surfaces, natural size.

31 1710



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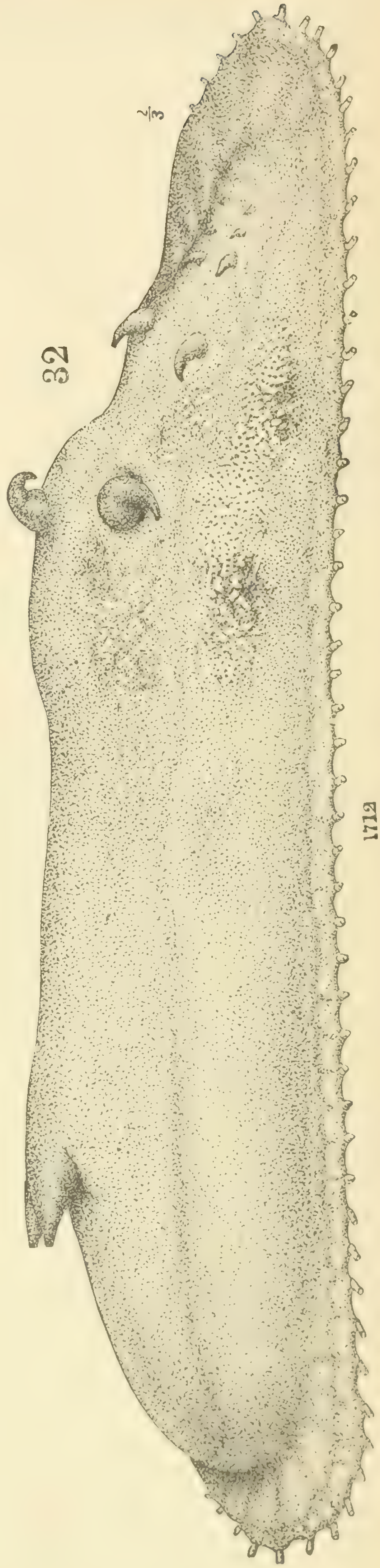


34 a 1715

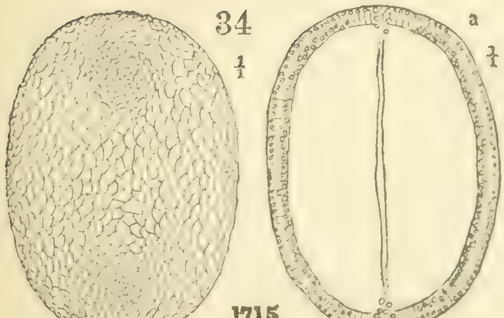
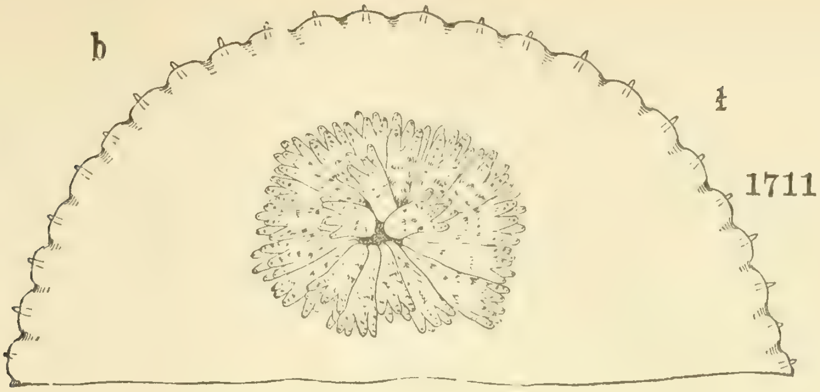


PLATE XI.

Fig. 31 *a*. *Benthodytes gigantea* V. View of the under surface of a small specimen, one-half natural size. From a specimen kept a short time in alcohol.

Fig. 31 *b*. The same. Ventral surface of the anterior part of a similar specimen having the tentacles more expanded, natural size.

31 *b*



31 *a*

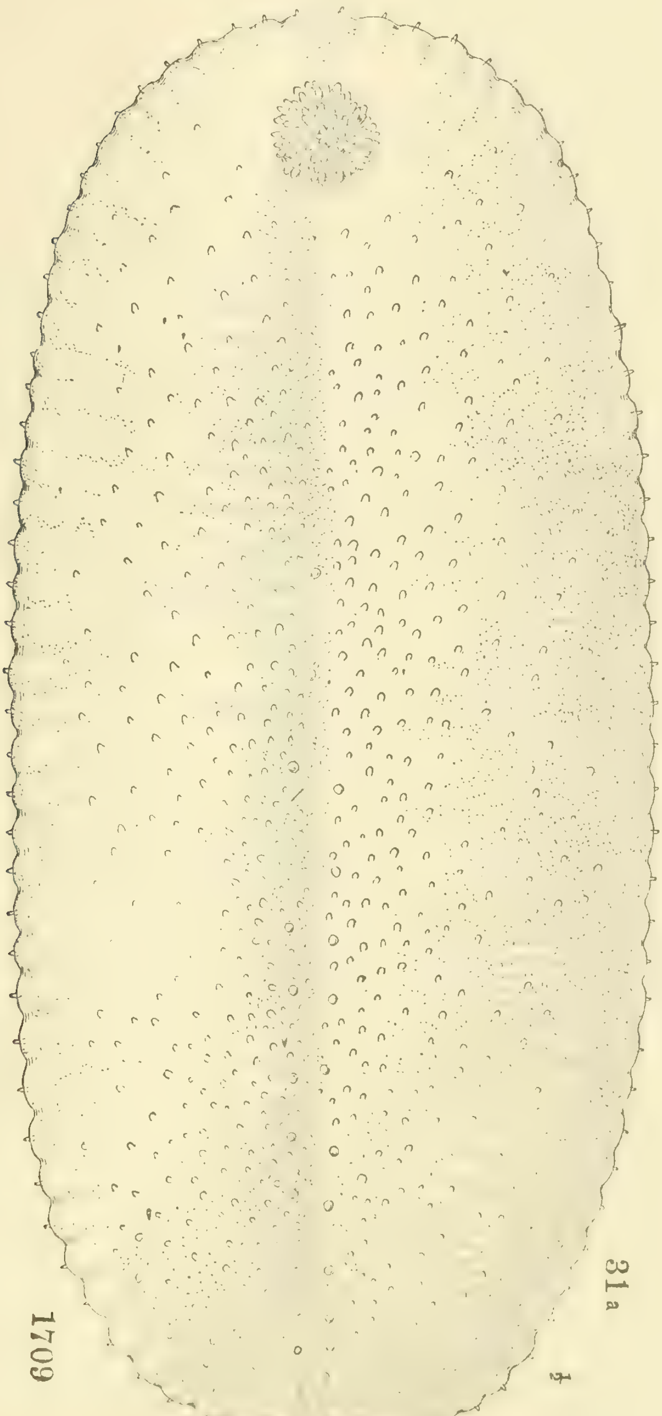


PLATE XII.

FIG. 33. *Euphronides cornuta* V. Upper surface of a specimen preserved a short time in alcohol, two-thirds natural size.

FIG. 33*a*. The same. Lower surface of the same specimen, two-thirds natural size.

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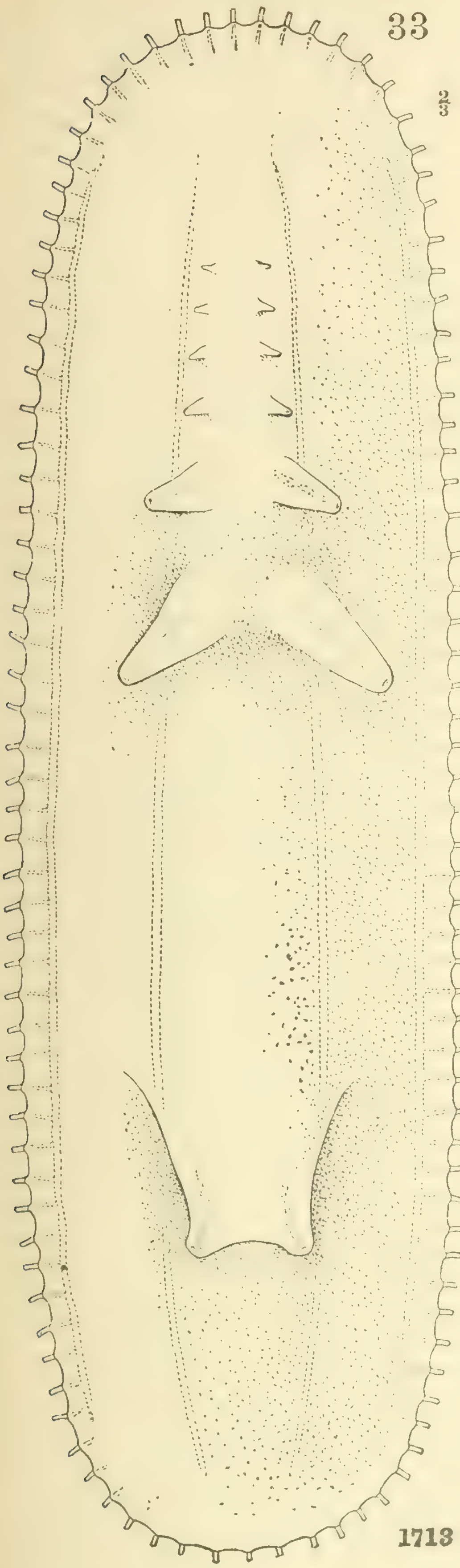

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33 a

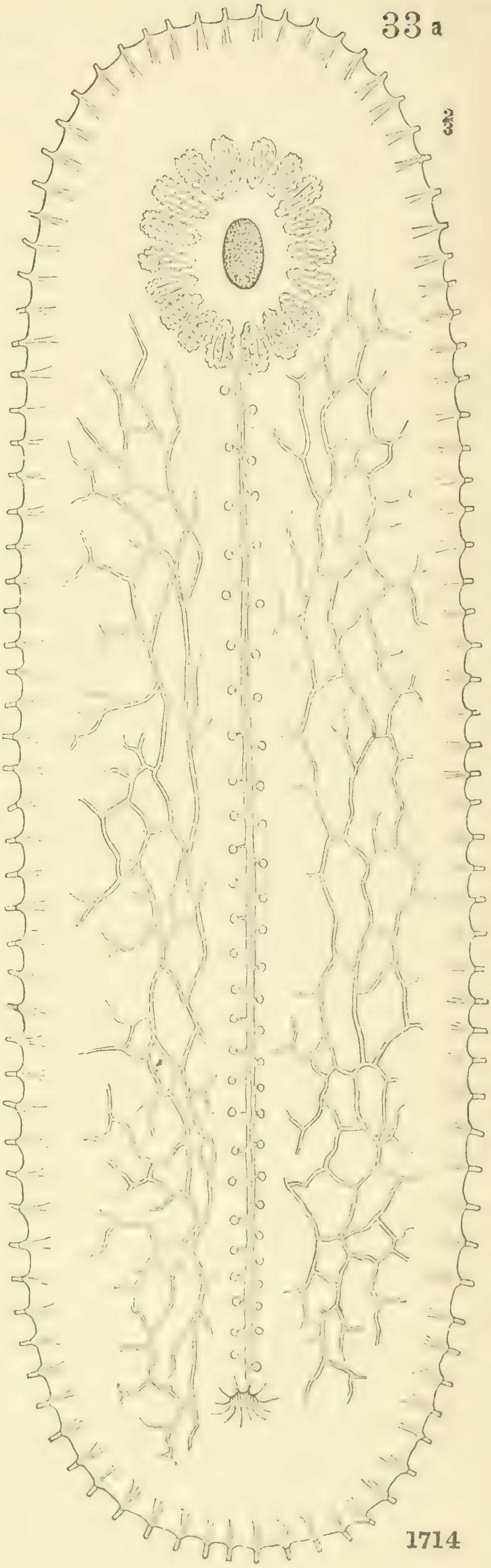

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PLATE XIII.

FIG. 35. *Pteraster militaris.* Lower surface, somewhat reduced. After M. Sars.

FIG. 36. *Archaster Floræ* V. One-half natural size. Copied from a photograph.

FIG. 37. *Archaster Parelii.* Lower surface, nearly natural size. Copied from a photograph.

FIG. 38. *Archaster tenuispinus.* Upper surface of the middle portion of an arm, enlarged two diameters.

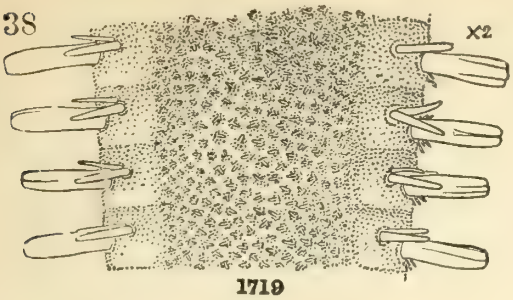
FIG. 39. *Euidia elegans.* Upper surface of the middle portion of an arm, enlarged one and one-half diameters; *a*, the same, transverse section from an alcoholic specimen.

FIG. 42. *Asterias Tanneri* V. Dorsal view of one of the arms of a living specimen, three-fourths natural size.

FIG. 42 *a*. The same. Middle portion of an arm, enlarged two diameters.

FIG. 50 *b*. *Solaster Earlii.* Lower surface of the middle portion of an arm, somewhat enlarged. (See Plate XIX.)

38 ×2



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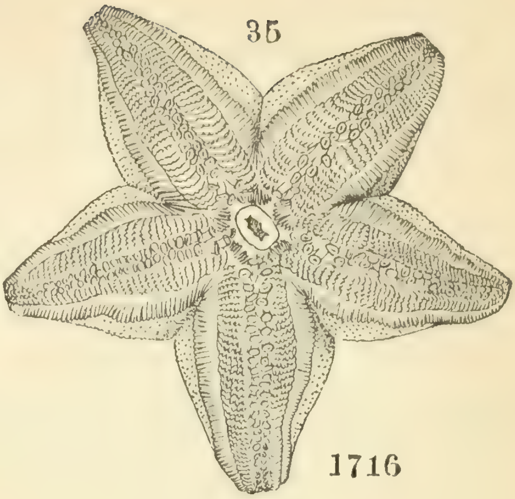

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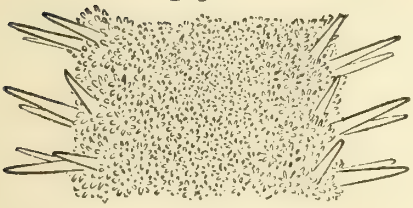

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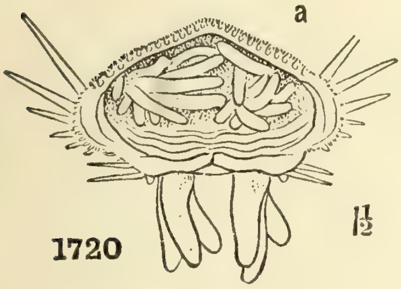

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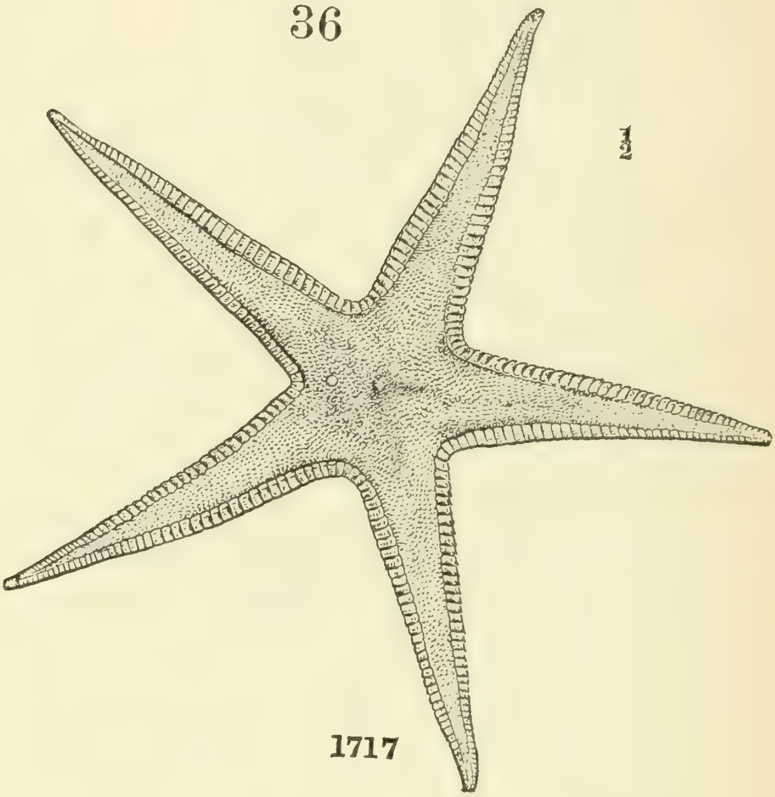
36 1/2



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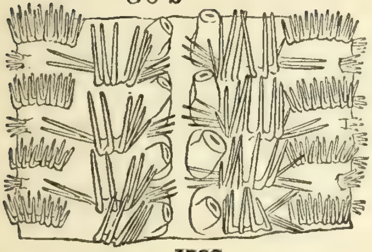

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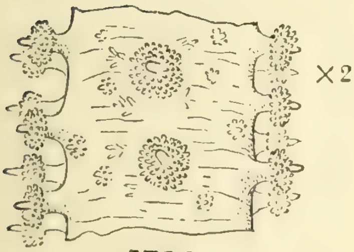
42 *a*

a ×2



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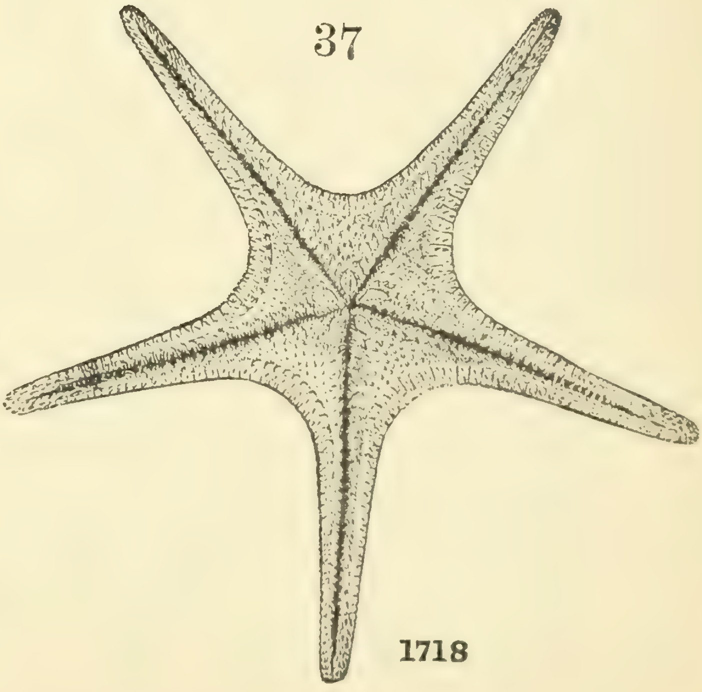

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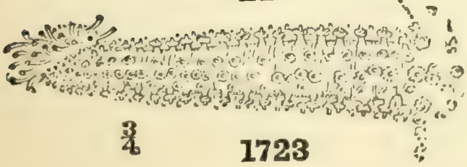
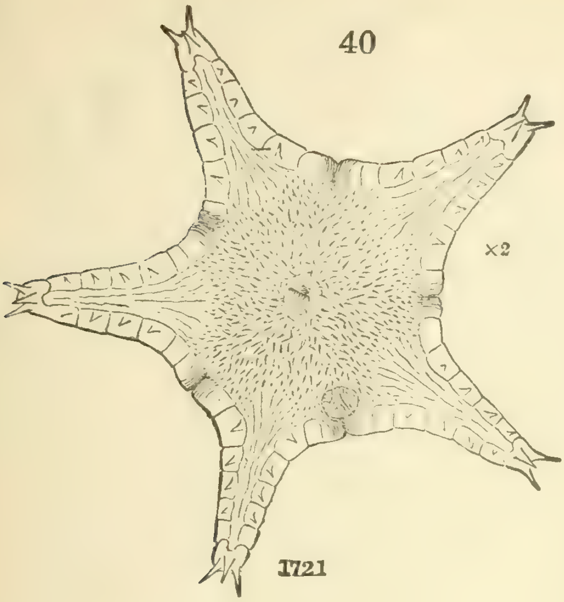


3/4 1723

PLATE XIV.

FIG. 40. *Porcellanaster cœruleus.* Upper surface, enlarged two diameters.
FIG. 41. The same. Actinal surface.
FIG. 43. *Diplopteraster multipes.* Actinal surface, two-thirds natural size.
(Figs. 40 and 41 were drawn by J. H. Blake; Fig. 43, by J. H. Emerton.)

40



×2

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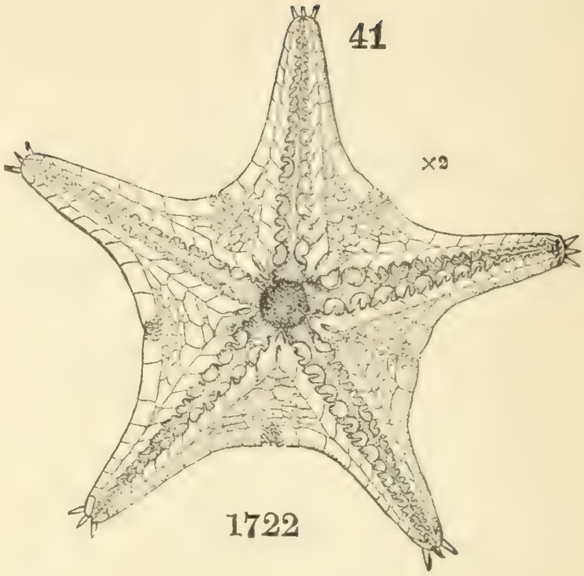

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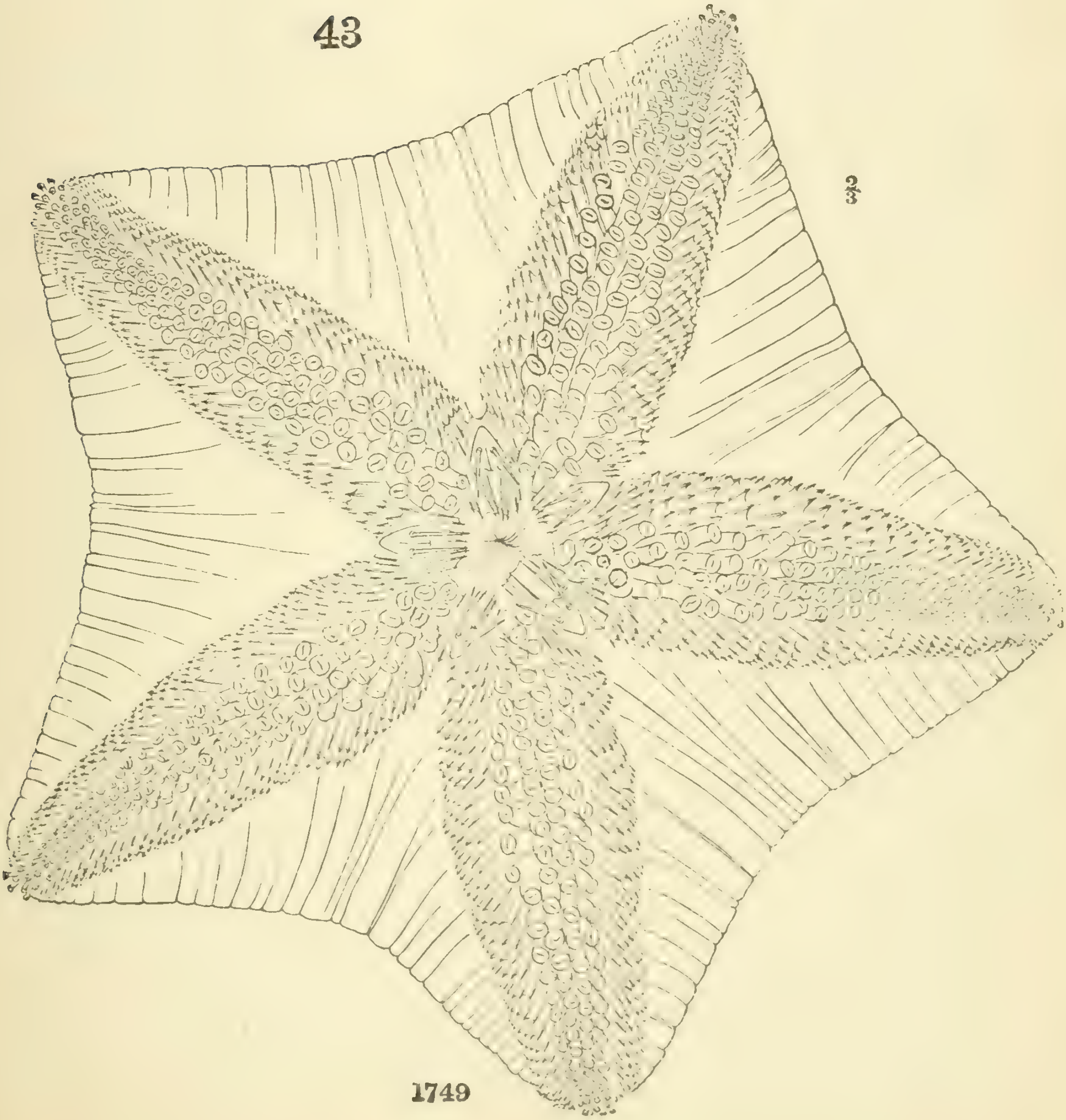
43



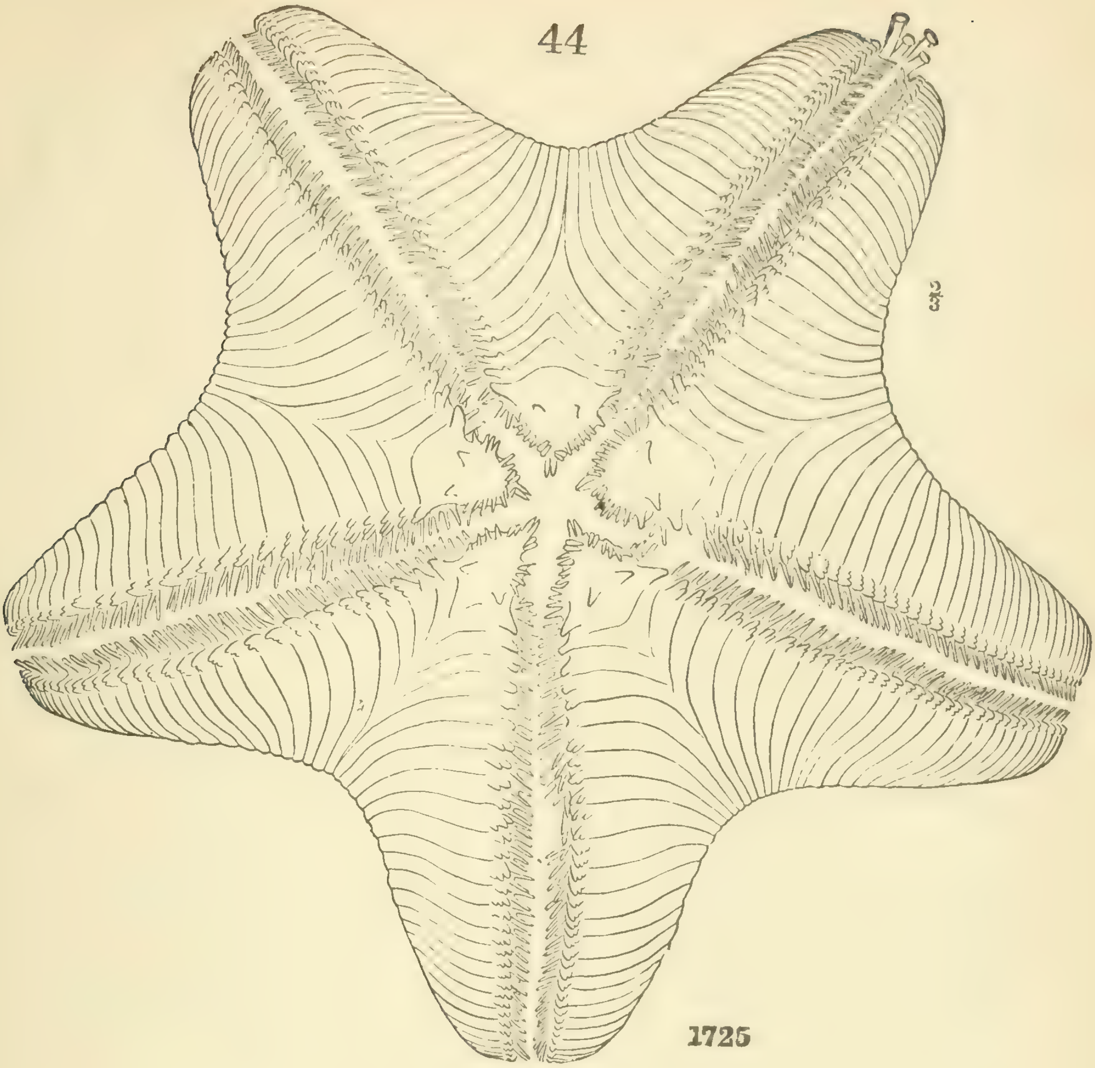
$\frac{2}{3}$

1749

PLATE XV.

FIG. 44. *Porania grandis* V. Actinal surface, two-thirds natural size.
FIG. 45. The same. Actinal surface of a young specimen, natural size.
FIG. 45 *a*. The same specimen. Abactinal surface.

44



$\frac{2}{3}$

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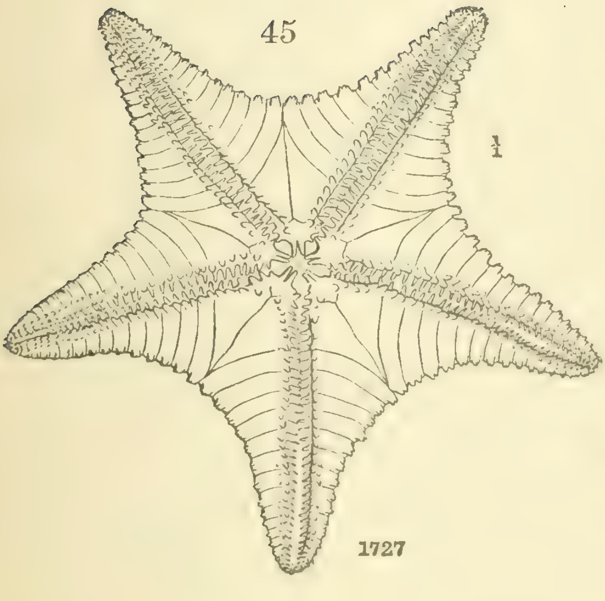

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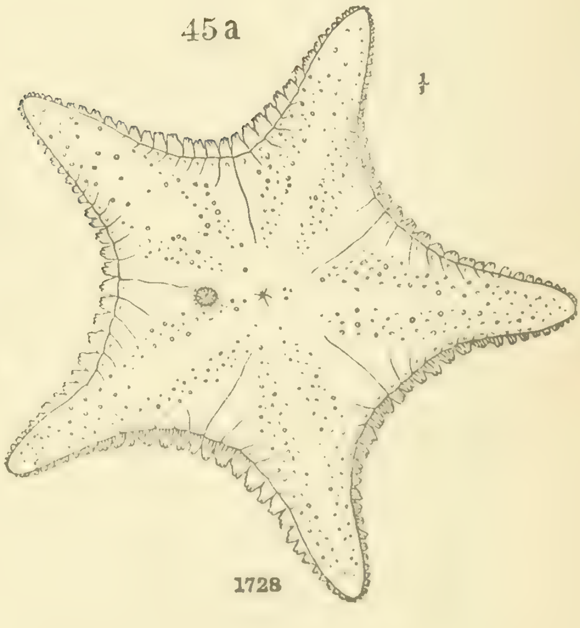
1727

45 a



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1728

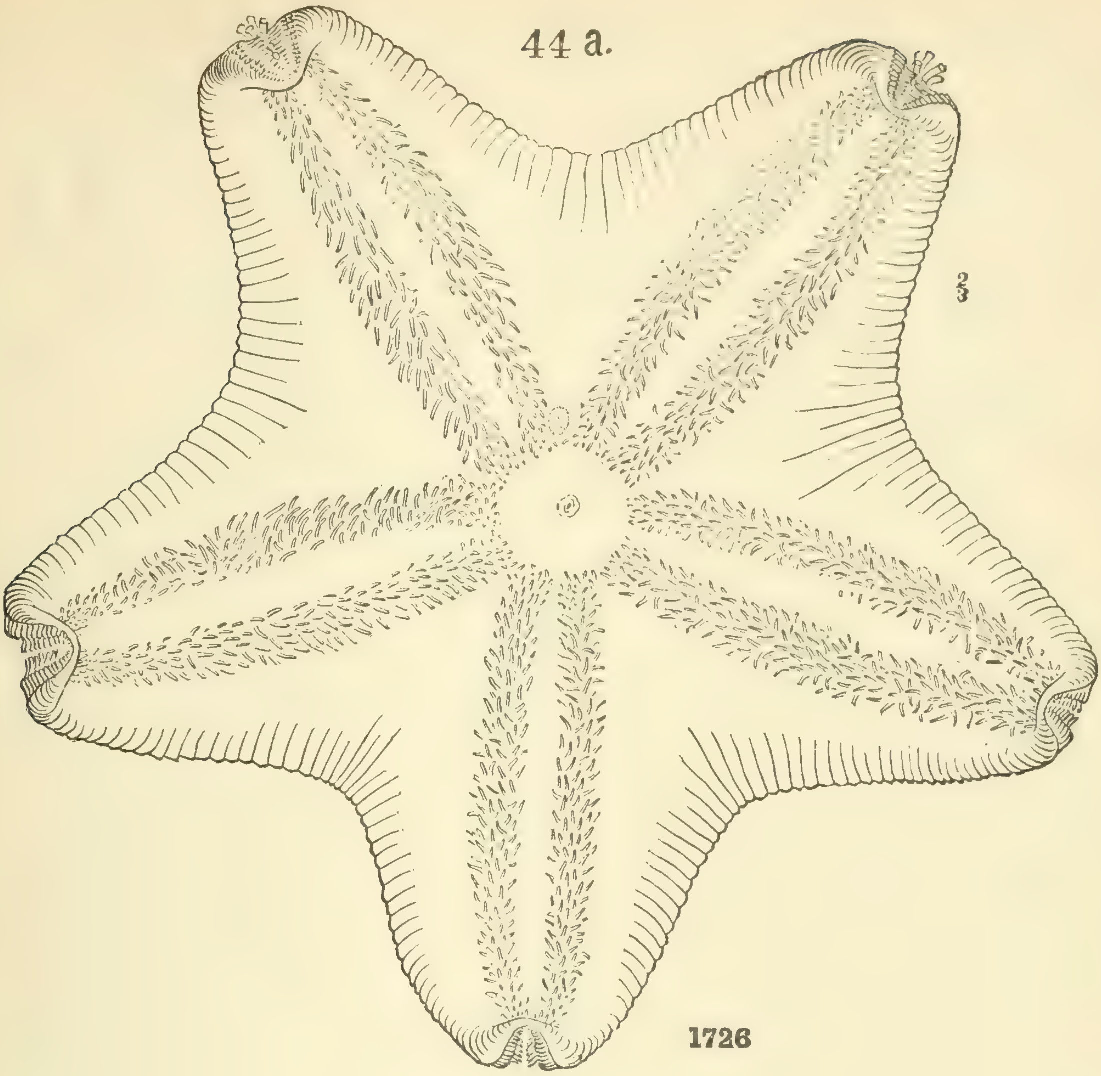
PLATE XVI.

FIG. 44 *a*. *Porania grandis* V. Actinal surface, two-thirds natural size. From the same specimen as Fig. 44, which was alive but not in full vigor when drawn.

FIG. 49. *Lophaster furcifer*. Abactinal surface of a small specimen, natural size.

FIG. 49 *a*. The same specimen. Actinal surface.

44 a.



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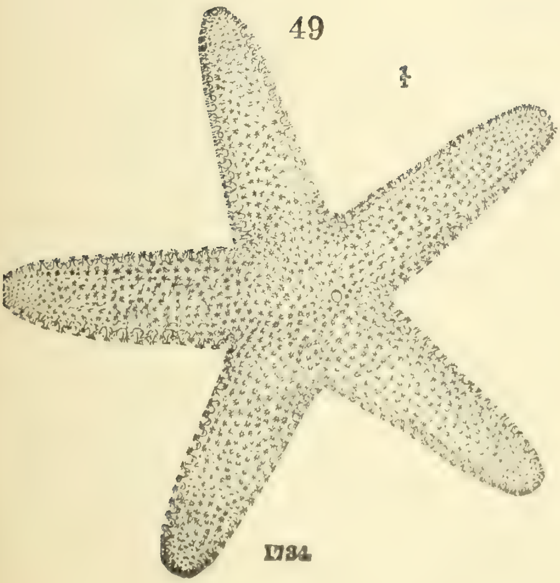

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49 a

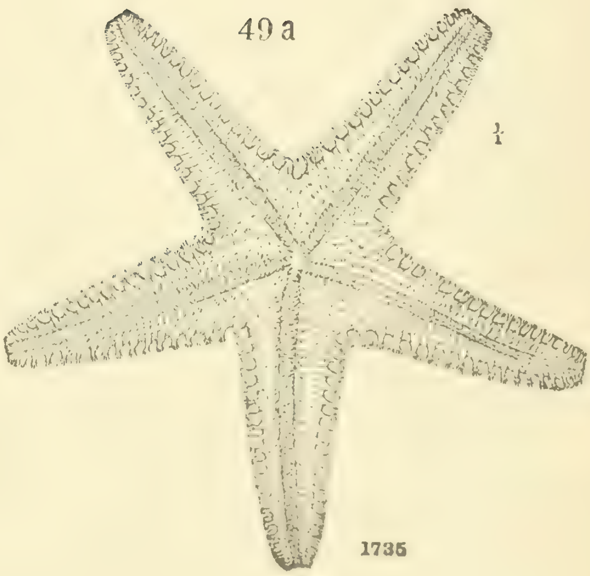

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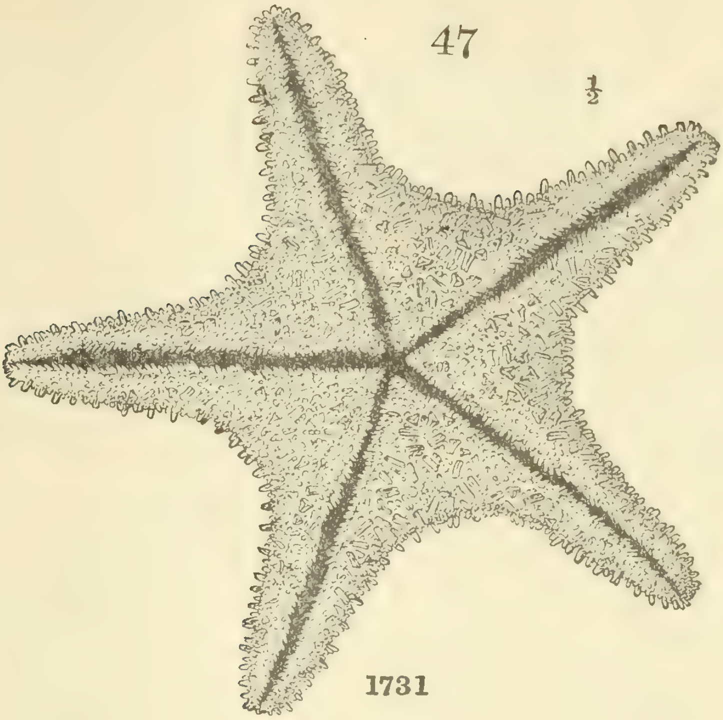
PLATE XVII.

FIG. 47. *Hippasteria phrygiana.* Actinal surface of a specimen having an unusual number and variety of pedicellariæ, one-half natural size. Copied from a photograph of a dry specimen.

FIG. 52. *Brisinga Americana* V. Side view of the basal portion of one of the arms, natural size; *a*, dorsal surface of the middle portion of an arm, natural size; *b*, the same, ventral surface. From one of the arms of the type specimen, preserved in alcohol, from the fishing banks off Nova Scotia.

47

½



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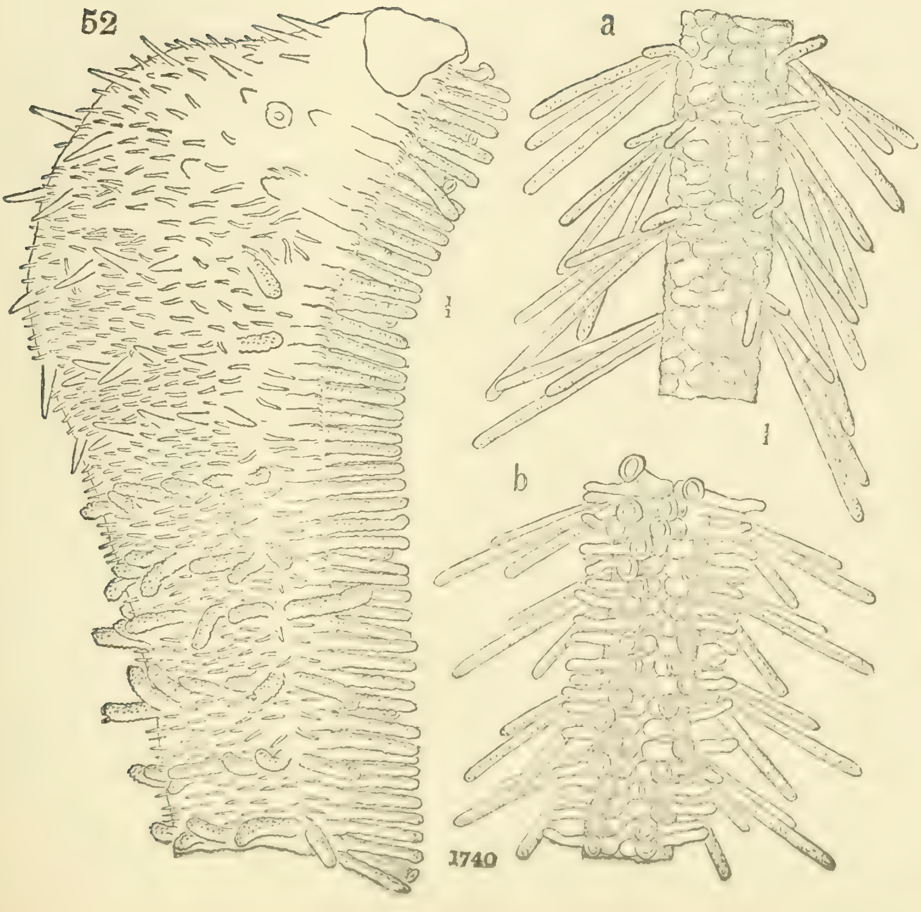


1740

PLATE XVIII.

FIG. 46. *Asterina borealis.* Actinal surface of the type specimen, enlarged two diameters.

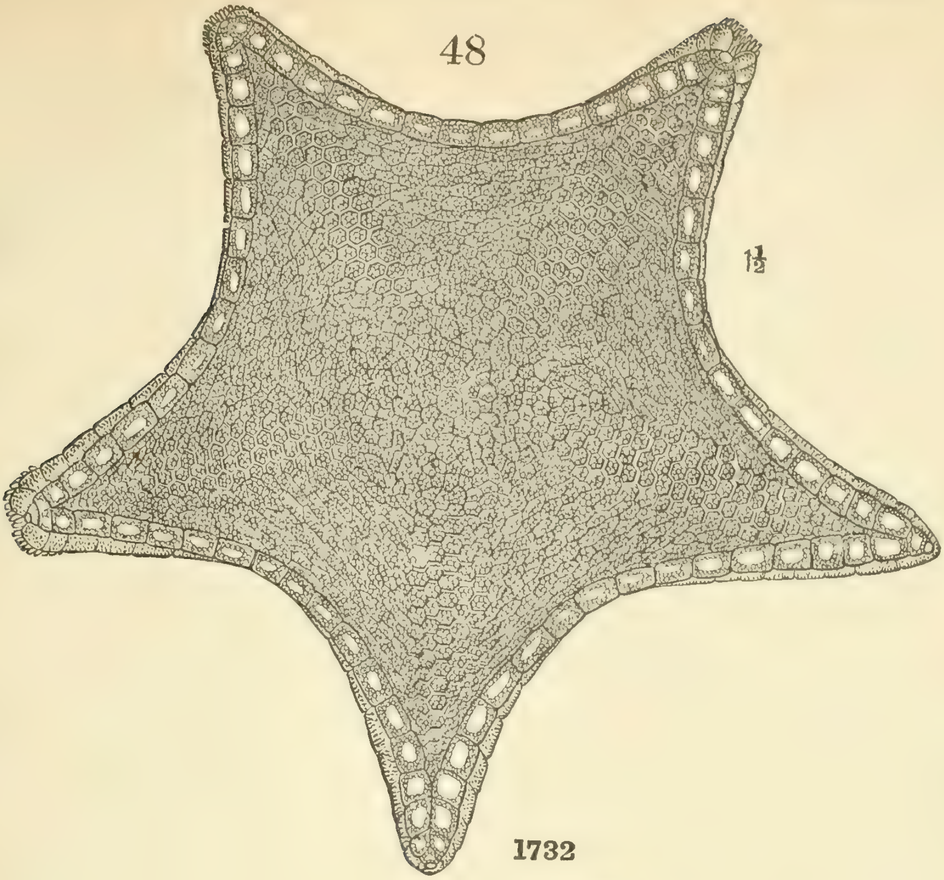
FIG. 46*a*. The same specimen. Abactinal surface.

FIG. 48. *Astrogonium granulare.* Abactinal surface of a small specimen, enlarged one and one-half diameters.

FIG. 48*a*. The same. Actinal surface, two-thirds natural size. Copied from photographs of dry specimens.

FIG. 51. *Tremaster mirabilis.* Profile view of one of the type specimens from the fishing banks off Nova Scotia, three-fourths natural size.

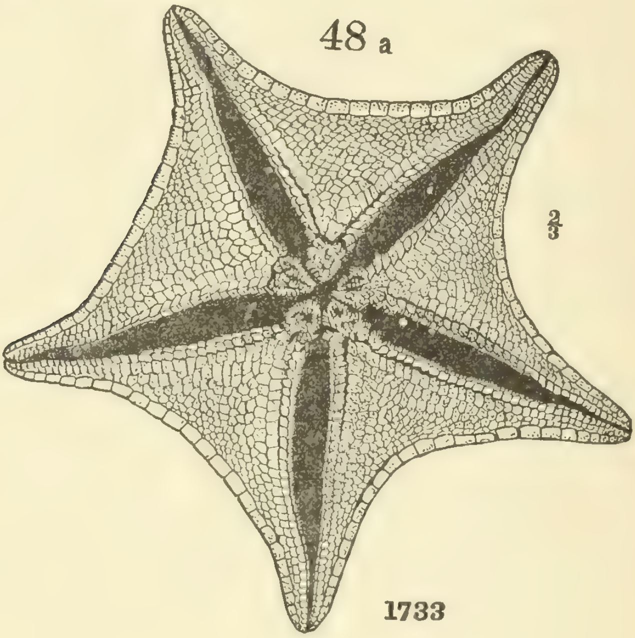
48



1½

1732

48 a



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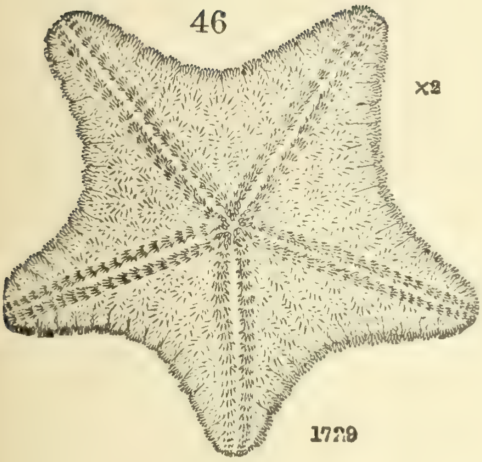
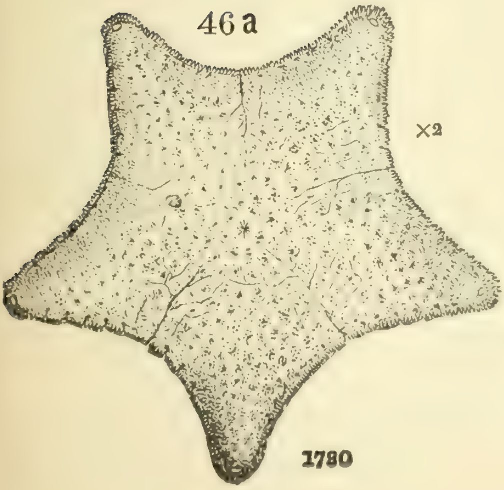


×2

1729

46 a



×2

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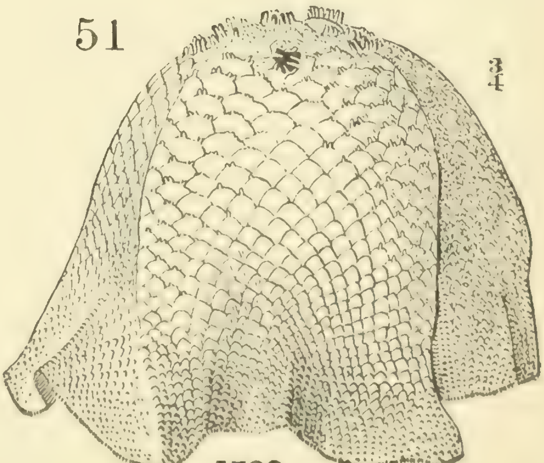

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1739

PLATE XIX.

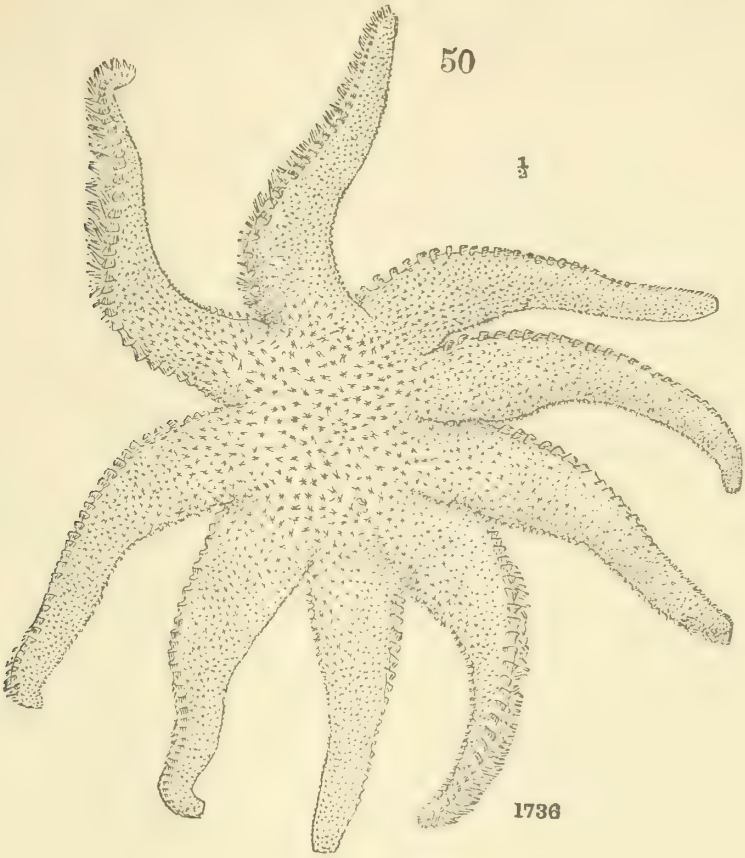
FIG. 50. *Solaster Earlii* V. Abactinal surface of one of the type specimens from the fishing banks off Nova Scotia, one-half natural size.

FIG. 50 *a*. The same specimen. Actinal surface.

Both figures were copied from photographs of a dried specimen.

50

$\frac{1}{2}$



50a

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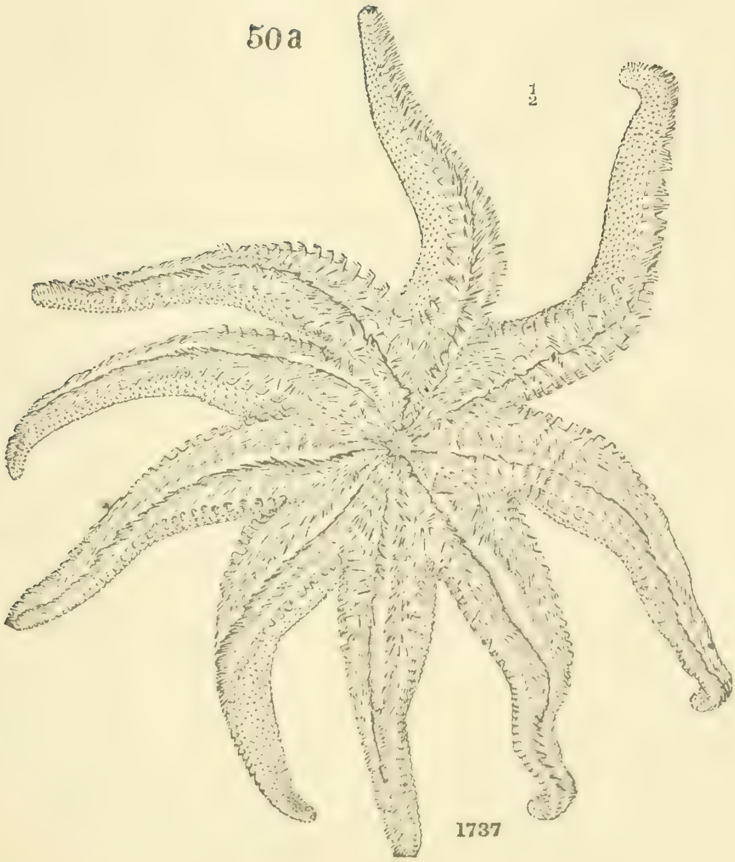


PLATE XX.

FIG. 53. *Astrochele Lymani* V. Abactinal surface of the type specimen, which is not full-grown, attached to a branch of *Acanella*, enlarged three diameters.

FIG. 54. *Astronyx Loveni*. Part of the actinal surface of a small specimen, enlarged four diameters; *a*, portion from the distal part of one of the arms, ventral side.

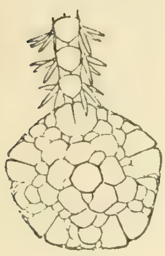
FIG. 54 *b*. One of the lateral rows of hooks and tentacles from the basal part of an arm, enlarged twenty-four diameters; *c*, two of the hooks from the distal portion of an arm.

FIG. 55. *Amphiura tenuispina*. Abactinal surface of a small specimen, enlarged about four diameters. From a camera lucida drawing by the author.

FIG. 56. *Ophioscolex quadrispinus* V. Actinal surface of a portion of the disk and arms, enlarged four diameters.

FIG. 56 *a*. The same. Portion of an arm from near the base. Ventral surface, enlarged eight diameters; *b*, the same, side view, showing the basal joints, which sometimes have five spines.

55



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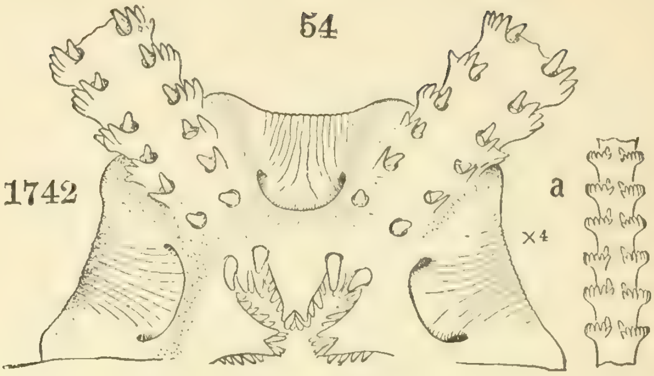

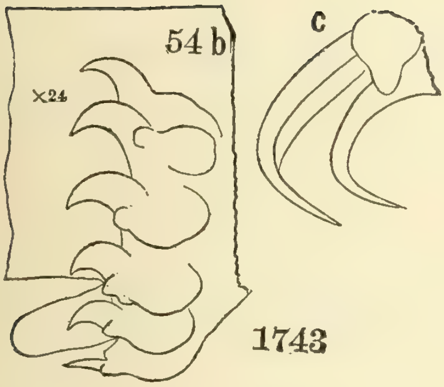

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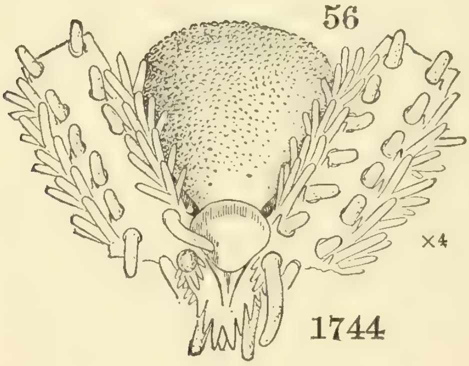

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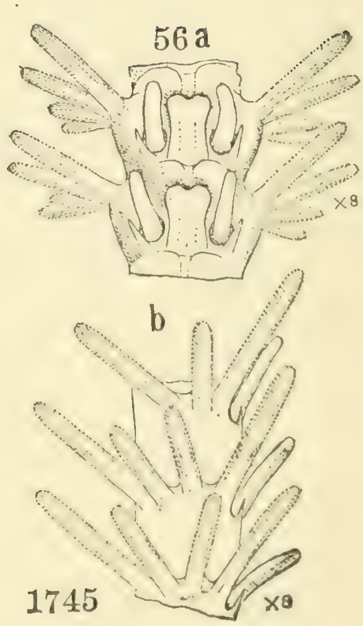


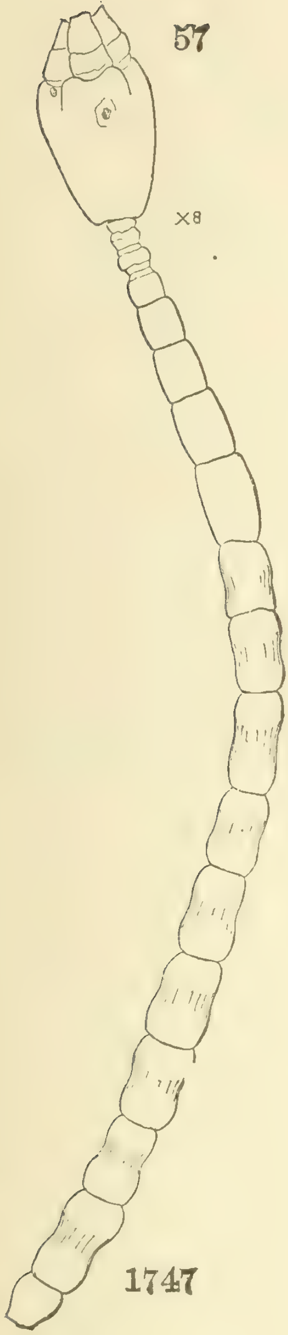
1745

PLATE XXI.

FIG. 57. *Rhizocrinus Lofotensis.* A young and somewhat imperfect specimen from 640 fathoms, enlarged eight diameters. The base of the stem and the tips of the arms are broken off.

FIG. 58. *Antedon dentata*, young. In the attached or pentacrinus stage, enlarged about eight diameters.

57



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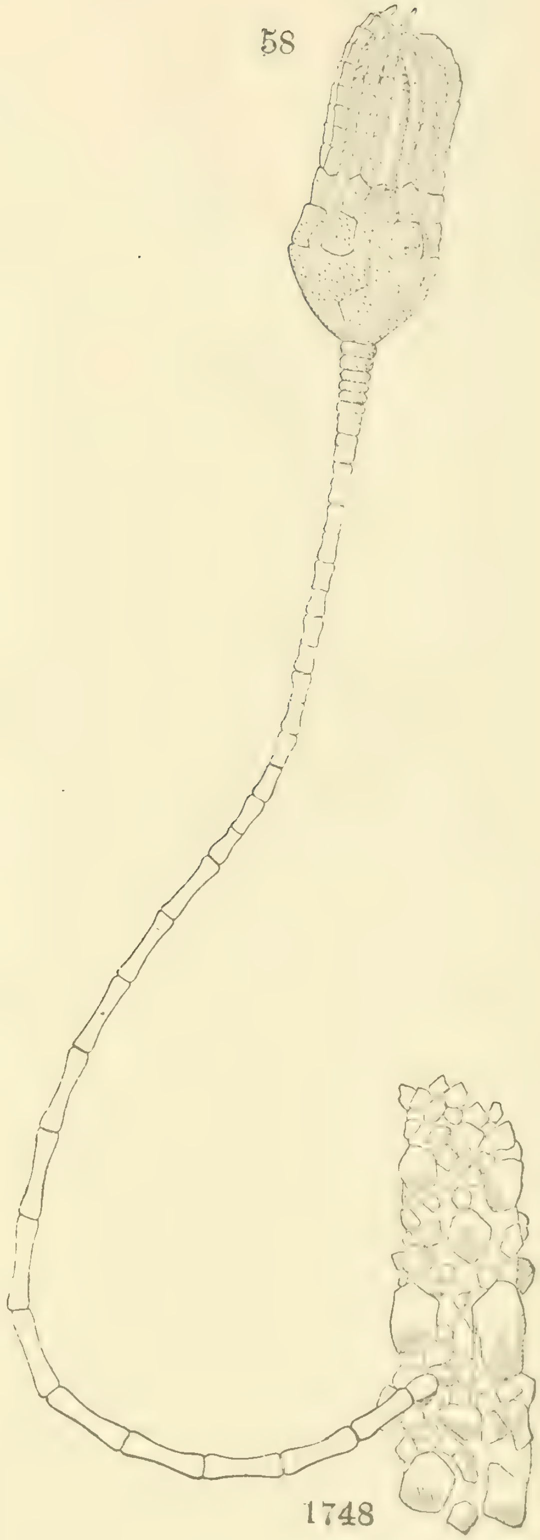


1748

PLATE XXII.

FIG. 60. *Abralia megalops* V. Ventral surface, enlarged one and one-half diameters. From a specimen which differed from the type in having raised verrucæ scattered on the lower surface.

FIG. 61. The same. One of the lateral arms, more enlarged.

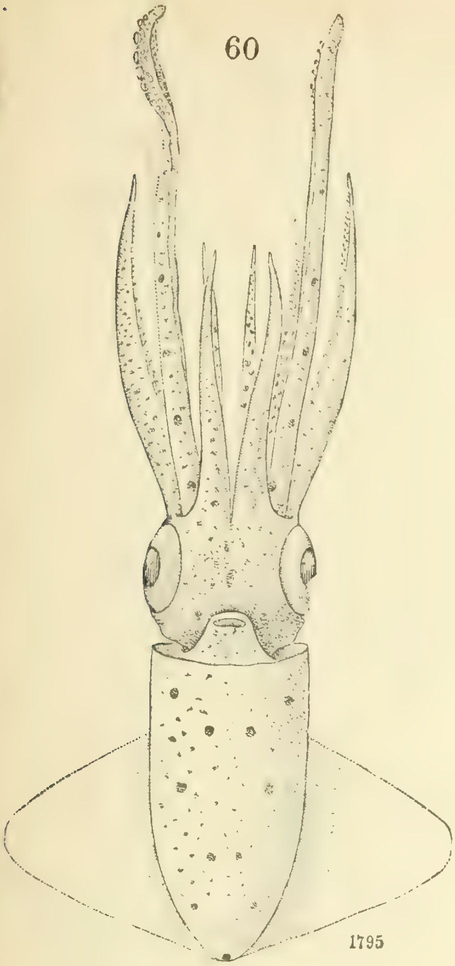
FIG. 62. *Leptoteuthis diaphana* V. Dorsal view of the type specimen, enlarged one and one-half diameters.

FIG. 64. *Eledonella pygmæa* V. One of the lateral arms of the type specimen, enlarged.

FIG. 65. *Octopus pictus* V. Dorsal view of the type specimen, enlarged four diameters.

PLATE XXII.

60



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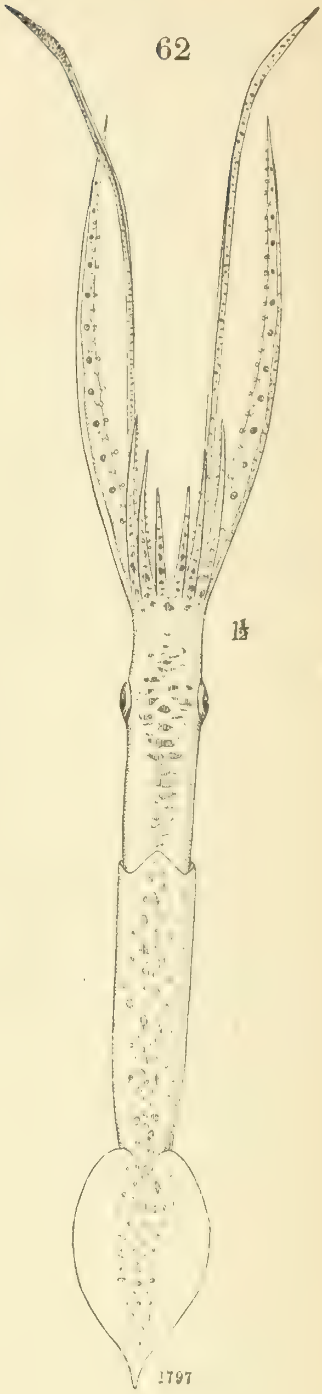

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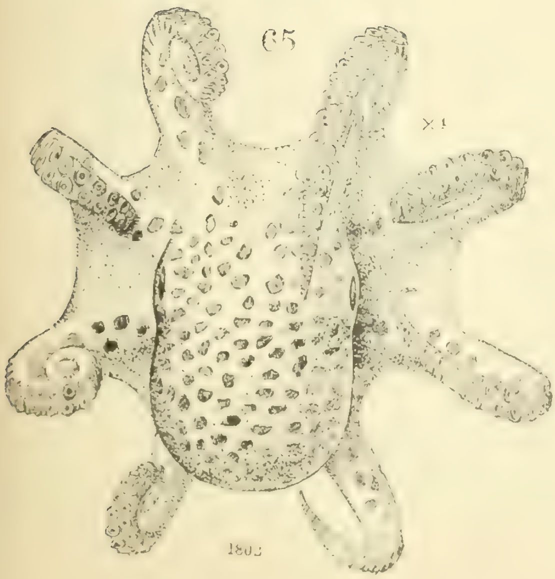


64

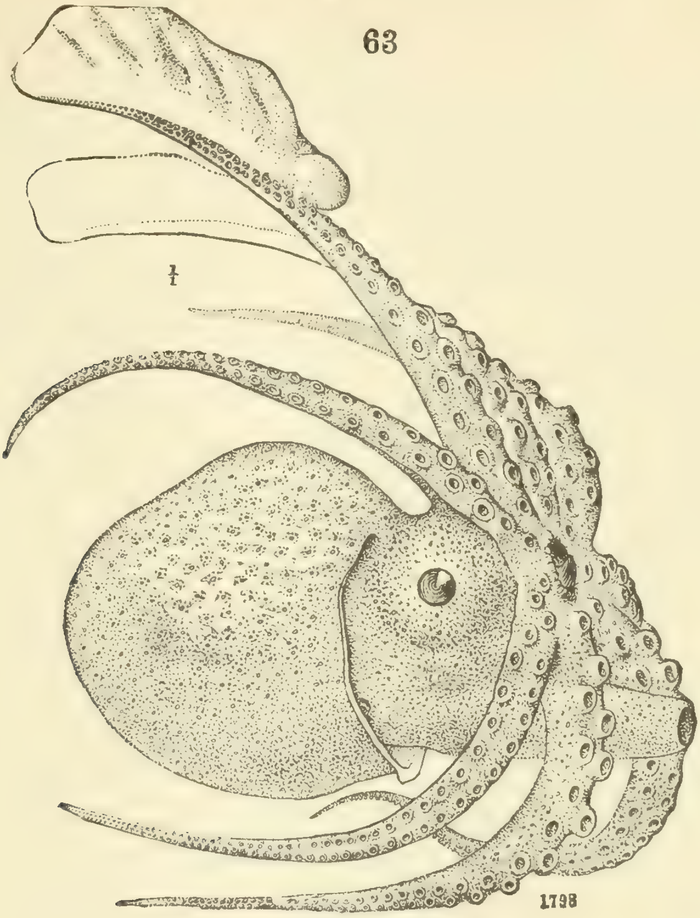
PLATE XXIII.

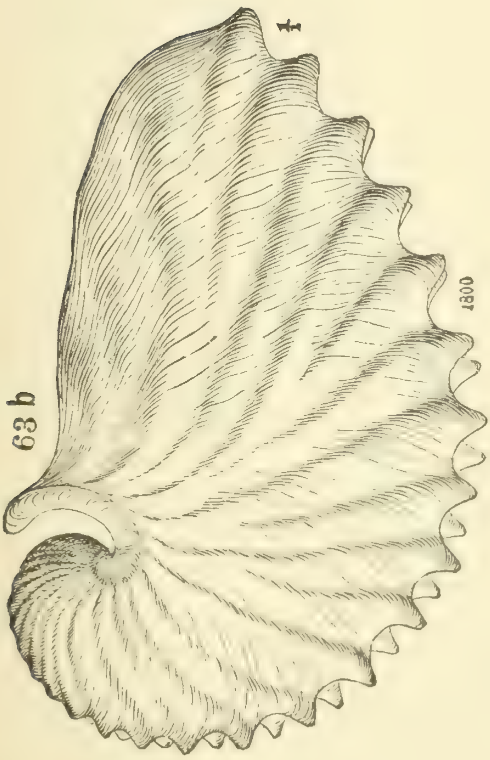
FIG. 63. *Argonauta argo.* Side view of the animal, natural size. From a young specimen taken off Long Island, at the surface.

FIG. 63 *a*. The same specimen. Front view of the shell, natural size.

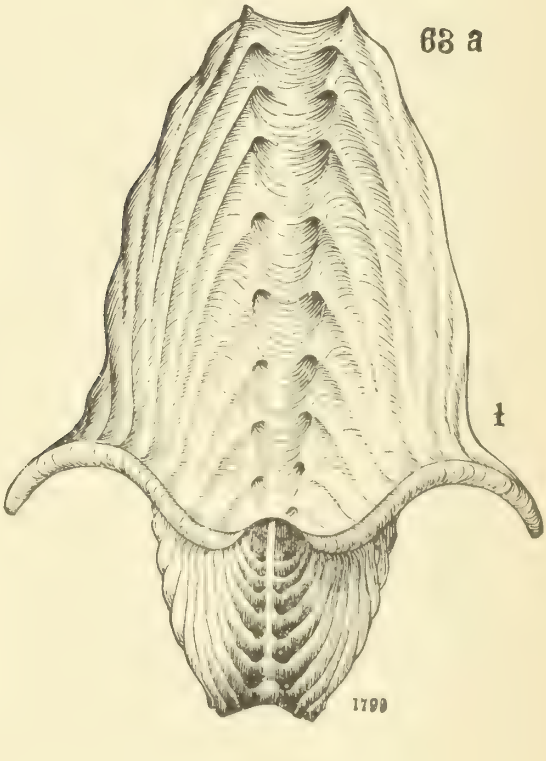
FIG. 63 *b*. The same specimen. Side view, natural size.

63





63 b



63 a

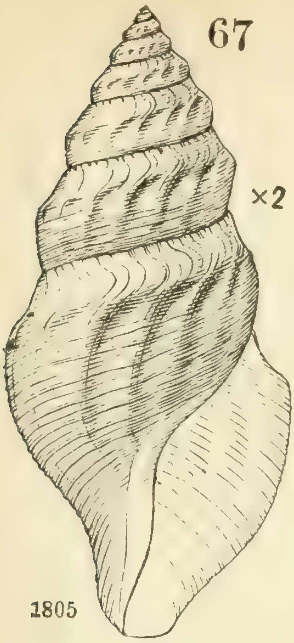
PLATE XXIV.

FIG. 66. *Pleurotoma Dalli*, enlarged two diameters.
FIG. 66 *a*. The same. Side view of the anterior whorls, enlarged two diameters.
FIG. 67. *Pleurotomella Agassizii* V., enlarged two diameters.
FIG. 68. *Pleurotomella Bairdii* V. Female, enlarged one and one-half diameters.
FIG. 69. *Pleurotomella Pandionis* V., enlarged one and one-half diameters.
FIG. 70. *Pleurotomella Benedicti* V. & S., enlarged three diameters.
FIG. 70 *a*. The same. To show nuclear whorls, enlarged twenty-two diameters.
FIG. 71. *Pleurotomella Sandersoni* V., enlarged six diameters.
FIG. 71 *a*. The same. To show nuclear whorls, enlarged twenty-two diameters.
FIG. 72. *Pleurotomella Saffordi* V. & S., enlarged four diameters.
FIG. 73. *Pleurotomella bandella*, enlarged four diameters.
FIG. 74. *Pleurotomella Emertoni* V. & S., enlarged three diameters.

Fig. 68 was drawn by Ensign W. E. Safford, U. S. N. The others, by J. H. Emerton.

PLATE XXIV.

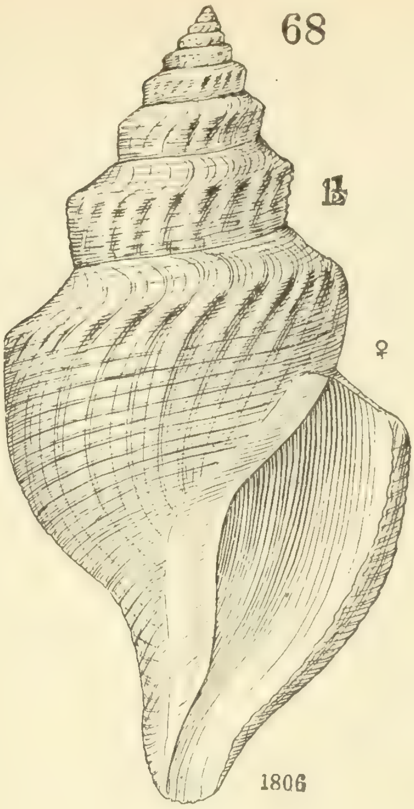
67



×2

1805

68

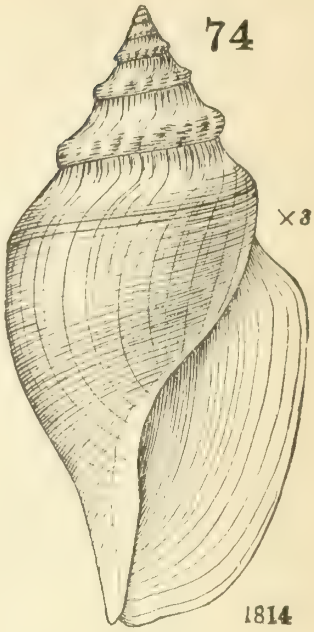


1½

♀

1806

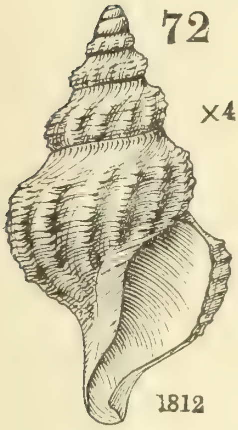
74



×3

1814

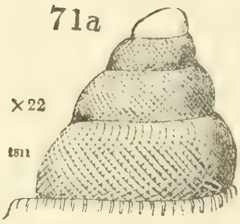
72



×4

1812

71a



×22

1811

66a

×2

1804

66

×2

1803

70

×3

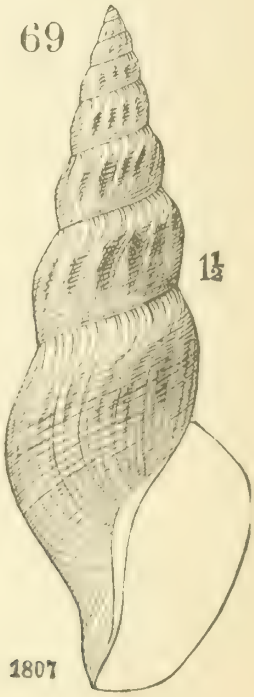
1808

71

×6

1810

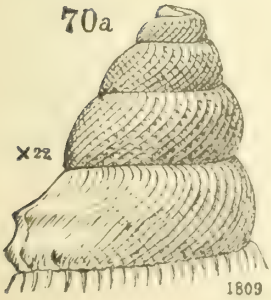
69



1½

1807

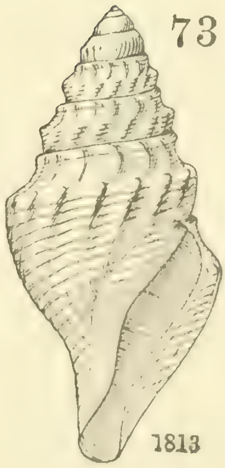
70a



×22

1809

73



1813

PLATE XXV.

FIG. 75. *Pleurotomella Bruneri* V. & S., enlarged six diameters.

FIG. 76. *Pleurotomella Catherinæ* V. & S., enlarged four diameters.

FIG. 76 *a*. The same. To show nuclear whorls, enlarged twenty-two diameters.

FIG. 77. *Taranis pulchella*, enlarged eight diameters.

FIG. 78. *Typhlomangilia Tanneri* V. & S., enlarged three diameters.

FIG. 79. *Marginella borealis* V., enlarged two diameters.

FIG. 80. *Buccinum abyssorum* V., enlarged one and one-half diameters; *a*, the operculum.

FIG. 81. *Sipho profundicola* V. & S., enlarged one and one-half diameters.

FIG. 82. *Sipho glyptus* V., enlarged two diameters.

FIG. 86. *Cingula Jan Mayeni*, enlarged eight diameters.

FIG. 90. *Scalaria Grœnlandica*. Dorsal view of the animal with the proboscis extended, and the two anterior whorls, enlarged about four diameters.

FIG. 91. *Scalaria Dalliana* V. & S., enlarged six diameters.

FIG. 92. *Scalaria Pourtalesii* V. & S. Female, enlarged three diameters.

FIG. 93. *Scalaria Leeana* V. Front view of an imperfect specimen, enlarged six diameters.

FIG. 94. *Scalaria Andrewsii* V., enlarged eight diameters.

PLATE XXV.

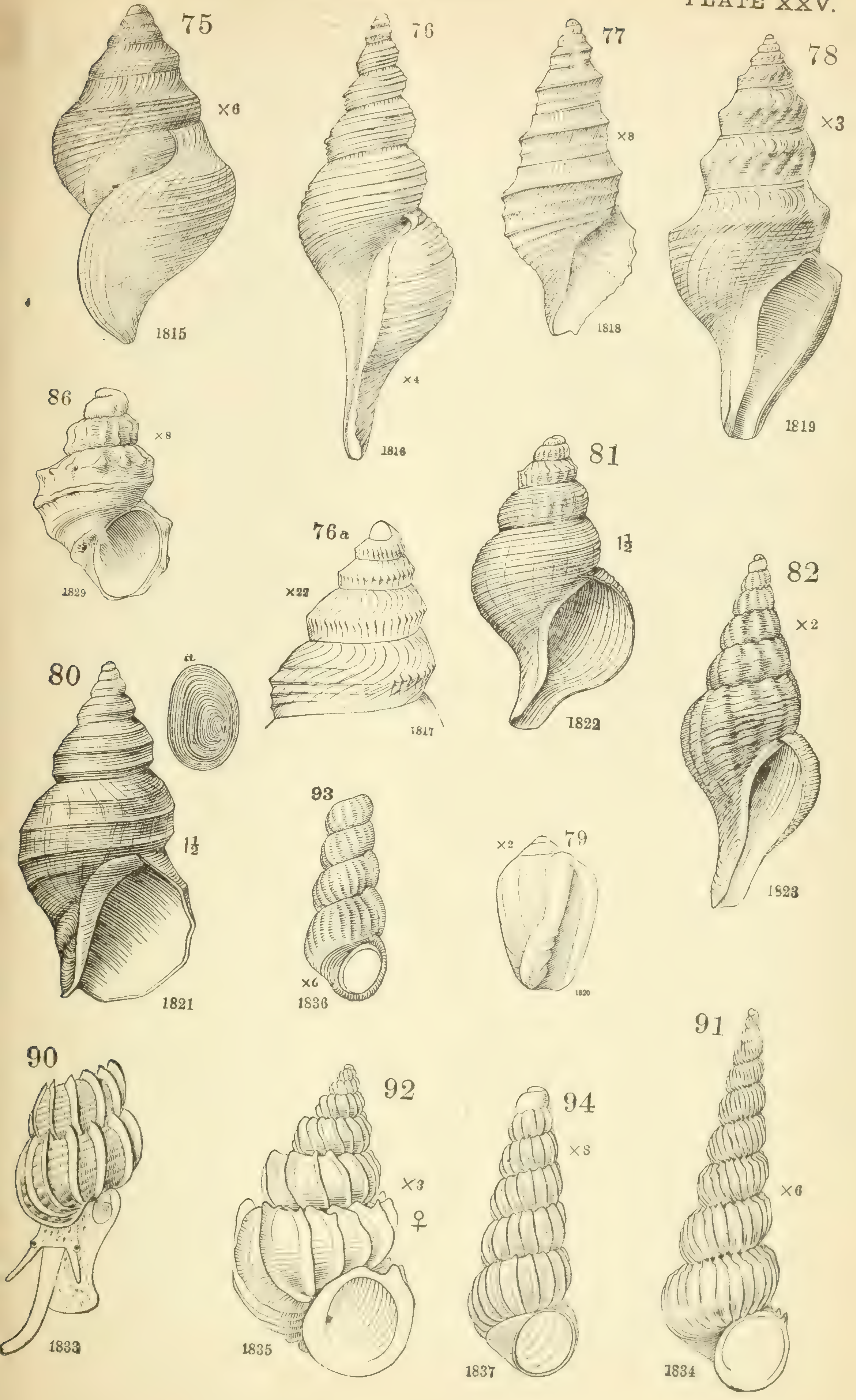

75
×6
1815
76
×4
1816
77
×8
1818
78
×3
1819
86
×8
1829
76a
×22
1817
81
1½
1822
82
×2
1823
80
a
1½
1821
93
×6
1836
79
×2
1820
91
×6
1834
90
1833
92
×3
♀
1835
94
×8
1837

Plate XXVI.

Fig. 83. *Dolium Bairdii* V. & S. Male, enlarged one and one-half diameters.
Fig. 83 *a*. The same. Animal of the male, two-thirds natural size.
Fig. 84. *Benthodolium abyssorum* V. & S., enlarged one and one-half diameters; *a*, operculum of the same specimen.
Fig. 84 *b*. The same. Part of the odontophore, enlarged one hundred diameters.
Fig. 85. *Torellia fimbriata* V. & S. Male, enlarged two diameters.
Fig. 87. *Fossarus elegans* V. & S., enlarged eight diameters.
Fig. 88. *Seguenzia formosa*, enlarged ten diameters.
Fig. 88 *a*. Operculum of the same.
Fig. 89. *Seguenzia eritima* V., enlarged ten diameters.

PLATE XXVI.

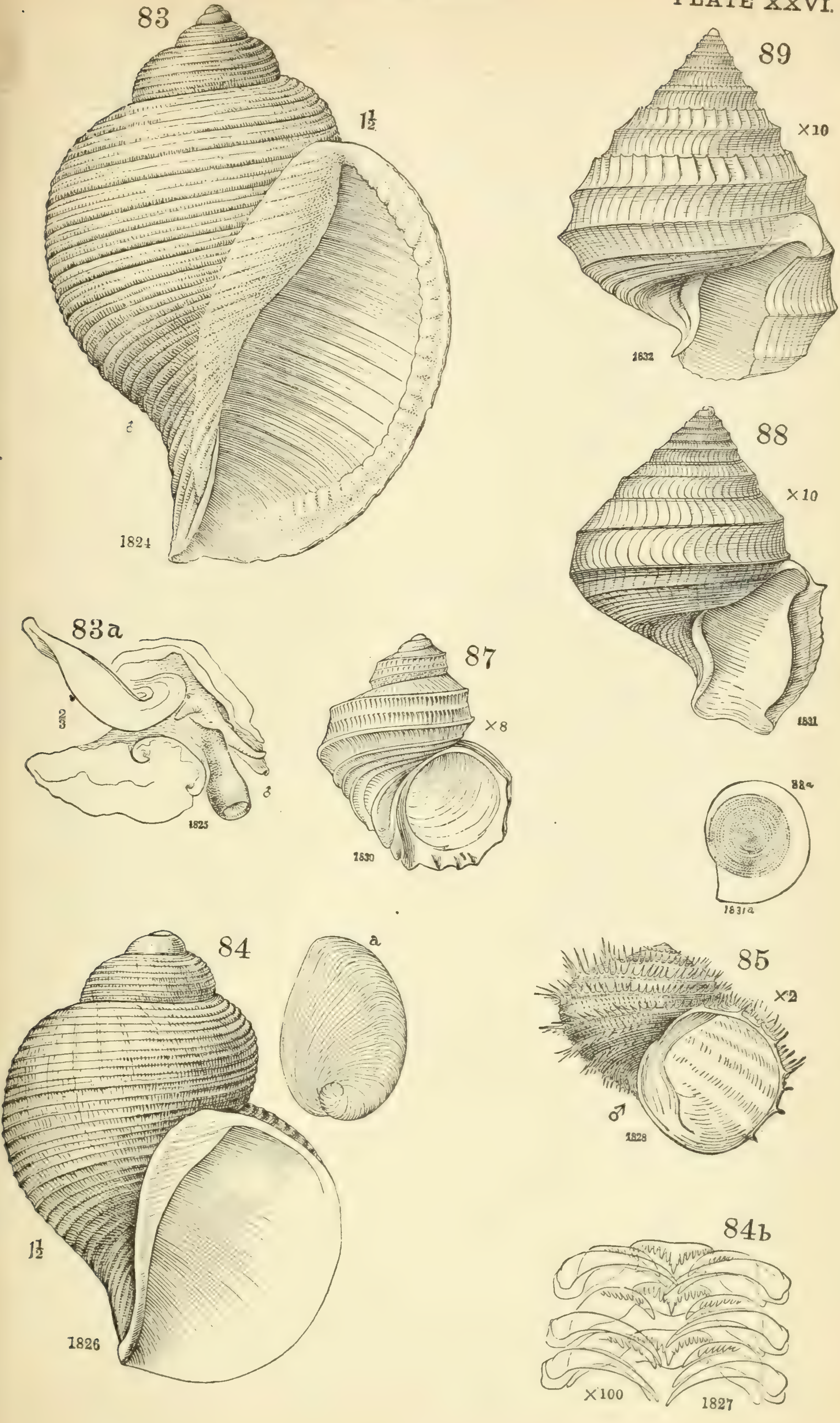

83
1½
1824
89
×10
1832
88
×10
1831
83a
⅔
1825
87
×8
1830
88a
1831a
84
a
1½
1826
85
×2
♂
1828
84b
×100
1827

Plate XXVII.

Fig. 95. *Solarium boreale*, enlarged three diameters.

Fig. 95 *a*. The same. Upper surface of a young specimen, enlarged six diameters.

Fig. 96. *Calliostoma Bairdii* V. & S. Dorsal view of the living animal and shell, enlarged one and one-half diameters.

Fig. 97. *Margarita regalis* V. & S., enlarged three diameters.

Fig. 98. *Margarita lamellosa* V. & S., enlarged eight diameters.

Fig. 99. *Cyclostrema Dalli* V., enlarged ten diameters.

Fig. 100. *Addisonia paradoxa*. Female. Ventral view of the animal and shell in alcohol, enlarged three diameters.

Fig. 100 *a*. The same. Side view of the shell, enlarged about two diameters.

Fig. 101. *Cocculina leptalea* V. Side view, much enlarged.

Fig. 102. *Placophora Atlantica*. Dorsal view, enlarged one and one-half diameters.

Fig. 102 *a*. The same specimen. Ventral view.

Fig. 103. *Amicula Emersonii*. Ventral view, two-thirds natural size; *a*, the posterior end, more enlarged.

Fig. 104. *Turbonilla Rathbuni* V. & S., enlarged four diameters.

PLATE XXVII.

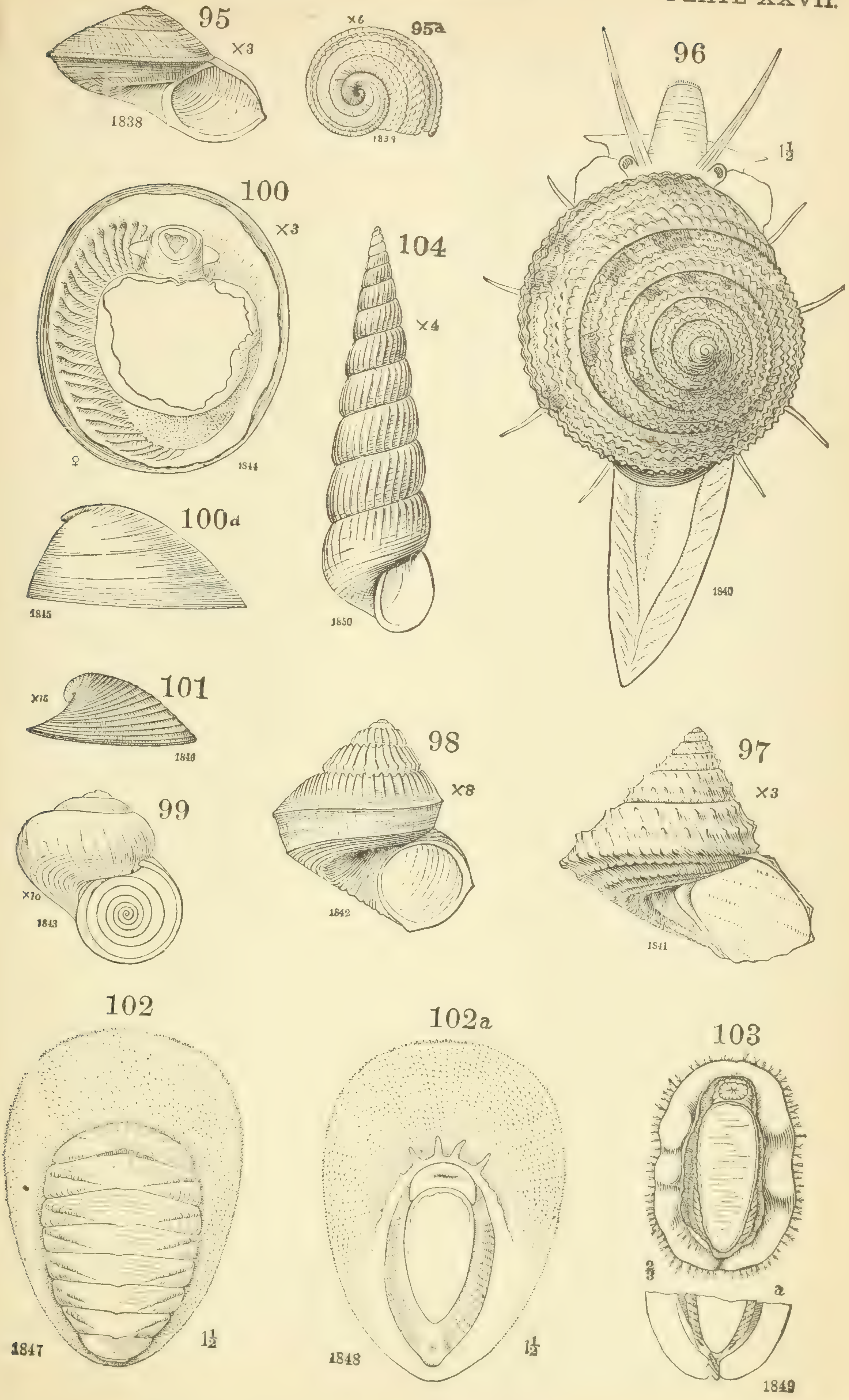

95
×3
1838
×6
95a
1839
96
$1\frac{1}{2}$
1840
100
×3
♀
1844
104
×4
1850
100a
1845
101
×16
1846
98
×8
1842
97
×3
1841
99
×10
1843
102
$1\frac{1}{2}$
1847
102a
$1\frac{1}{2}$
1848
103
$\frac{2}{3}$
a
1849

PLATE XXVIII.

FIG. 105. *Pleurobranchœa tarda* V. Dorsal view of a specimen in alcohol, two-thirds natural size.

FIG. 106. *Scaphander nobilis* V., natural size.

FIG. 107. *Koonsia obesa* V. Dorsal view of a specimen preserved a short time in alcohol, in which the dorsal part of the body is much contracted, two-thirds natural size.

FIG. 108. *Issa ramosa* V. & Em. Dorsal view of a living specimen, enlarged three diameters.

FIG. 108 *a*. The same. Part of the odontophore, much enlarged.

FIG. 109. *Scyllœa Edwardsii* V. Side view of a living specimen, two-thirds natural size.

FIG. 113. *Glaucus margaritaceus*. Ventral view of a nearly mature specimen, considerably enlarged.

FIG. 113 *a*. The same. Dorsal view of a younger specimen, much enlarged; *b*, view of a still smaller specimen.

FIG. 123. *Dentalium occidentale*, enlarged four diameters.

FIG. 124. The same. A small specimen of a more curved variety, enlarged two diameters.

FIG. 125. The same. View of a young specimen with more numerous sulcations, enlarged four diameters; *a*, transverse section of the same.

FIG. 126. *Cadulus Pandionis* V. & S., enlarged about three diameters; *a*, front view of the anterior end to show the aperture.

Fig. 109 was drawn from life by Ensign W. E. Safford, U. S. N.

Figs. 113 and 113 *a* were copied from sketches made at sea by Mr. A. Baldwin.

PLATE XXVIII.

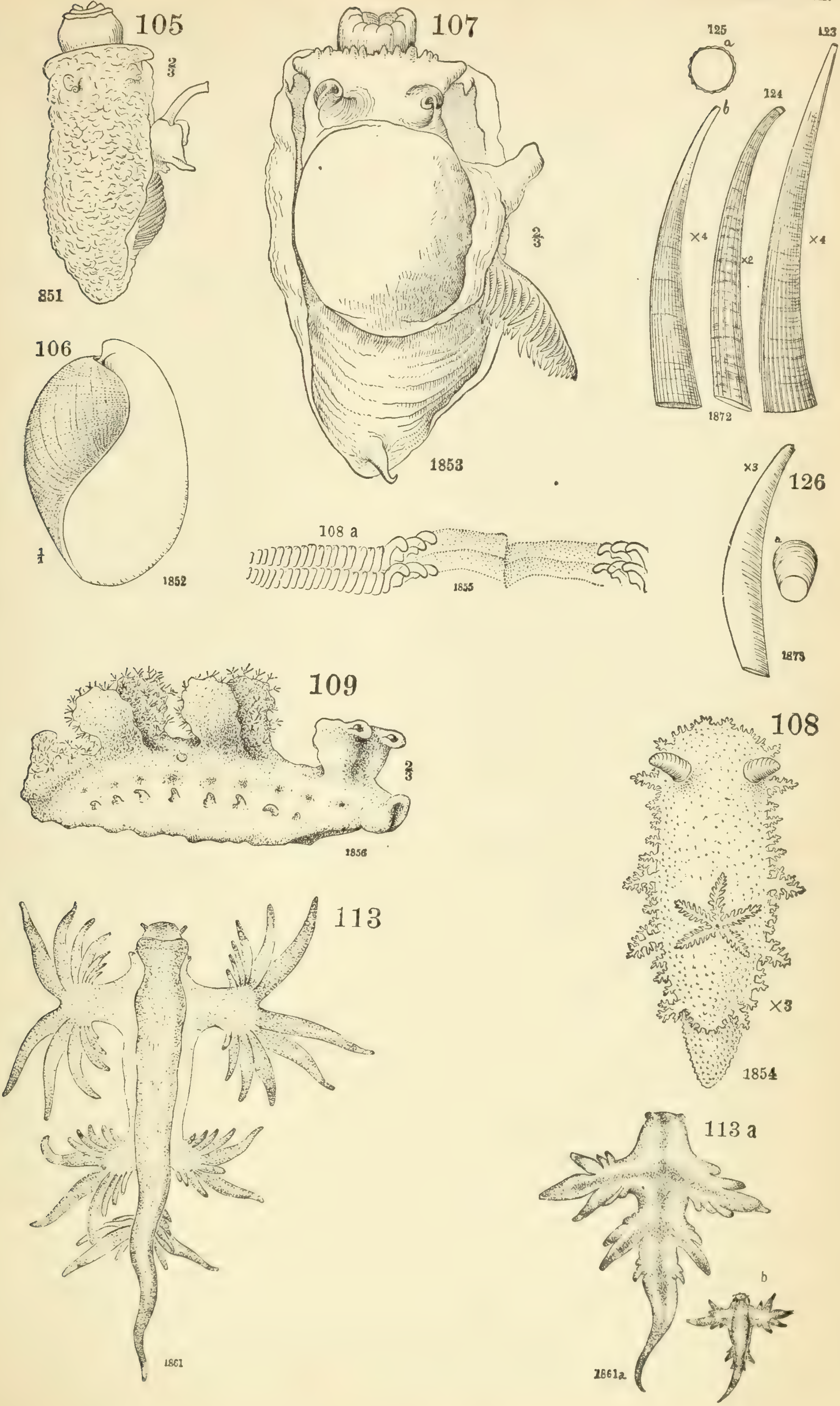


PLATE XXIX.

FIG. 110. *Atlanta Peronii.* Side view of a somewhat broken specimen, enlarged eight diameters.

FIG. 110 *a.* The same specimen. Front view.

FIG. 111. *Atlanta Gaudichaudii.* Side view, much enlarged.

FIG. 112. *Firola Keraudrenii.* Side view of a specimen preserved a short time in alcohol, enlarged four diameters.

FIG. 114. *Pleuropus Hargeri* V. Side view of one of the type specimens, preserved in alcohol.

FIG. 115. *Diacria trispinosa.* Expanded animal and shell, enlarged about two diameters.

FIG. 116. *Cavolina uncinata.* Expanded animal and shell, enlarged about two diameters.

FIG. 117. *Triptera columnella.* Expanded animal and shell, much enlarged.

FIG. 118. *Styliola recta.* Shell, much enlarged.

FIG. 119. *Styliola striata.* Expanded animal and shell, much enlarged.

FIG. 120. *Cymbulia calceolus.* Front view of a specimen a short time in alcohol, two-thirds natural size.

FIG. 121. *Spongiobranchia australis.* Ventral view of the living animal, much enlarged.

FIG. 122. *Clione papilionacea.* Dorsal view of the living animal, enlarged two diameters.

Figs. 114, 118, and 122 were drawn by the author; 110, 112, and 120 by J. H. Emerton; 115, 116, 117, 119, and 121 were copied from Eydoux and Souleyet by Ensign W. E. Safford; Fig. 111 is a camera lucida drawing by Mr. Safford.

PLATE XXIX.

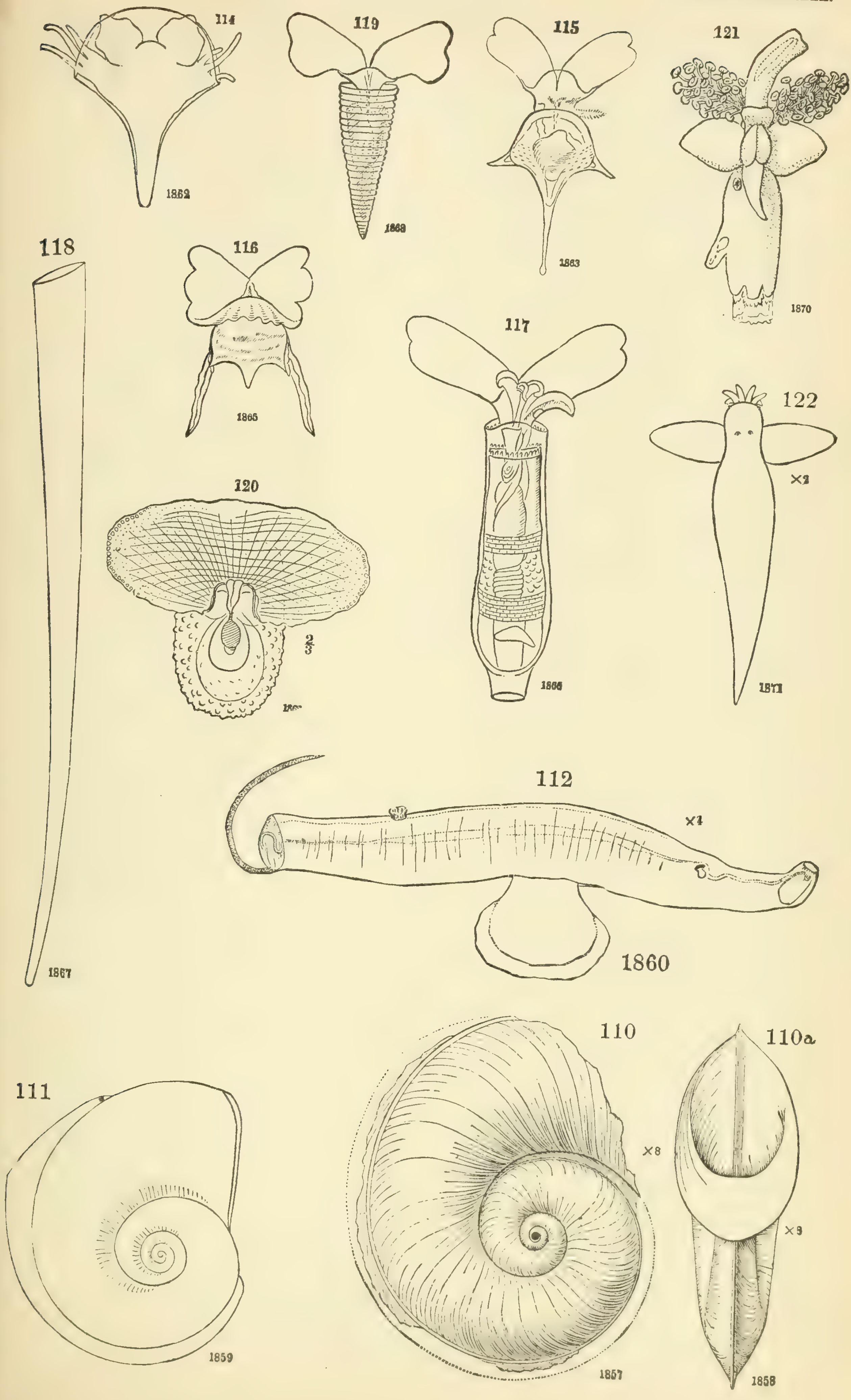

114
1862
119
1868
115
1863
121
1870
118
1867
116
1865
117
1866
122
×2
1871
120
2/3
112
×4
1860
110
×8
1857
110a
×8
1858
111
1859

PLATE XXX.

FIG. 127. *Teredo megotara.* Side view of the animal in expansion, one-half natural size.

FIG. 128. *Poromya sublevis* V. Inner surface of right valve, enlarged three diameters.

FIG. 129. *Neæra multicostata* V. & S., enlarged three diameters.

FIG. 130. *Thracia nitida* V. Type specimen, enlarged one and one-half diameters.

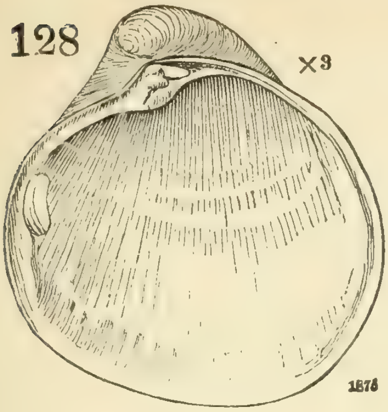
FIG. 131. *Verticordia cœlata* V. Type specimen, enlarged ten diameters; *a*, interior of the right valve; *b*, exterior of the same valve.

FIG. 132. *Mytilimeria flexuosa* V. & S. Type specimen, enlarged one and one-half diameters.

FIG. 133. *Pholadomya arata* V. & S. Portion of right valve of two specimens to show variations in the hinge, enlarged two diameters; *a*, form with more thickened hinge margin; *b*, shorter and more triangular form with thinner hinge margin.

FIG. 134. The same. Type specimen. Exterior of the right valve, enlarged one and one-half diameters.

FIG. 135. *Diplodonta turgida* V. & S. Interior view of right valve, enlarged one and one-half diameters.

128


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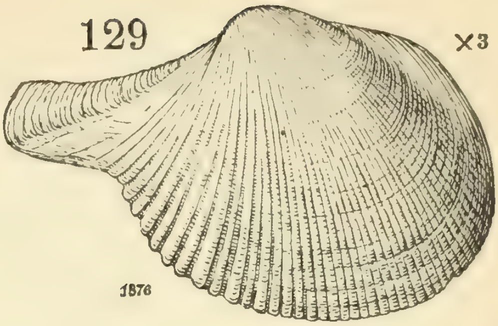

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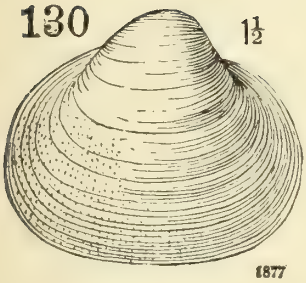

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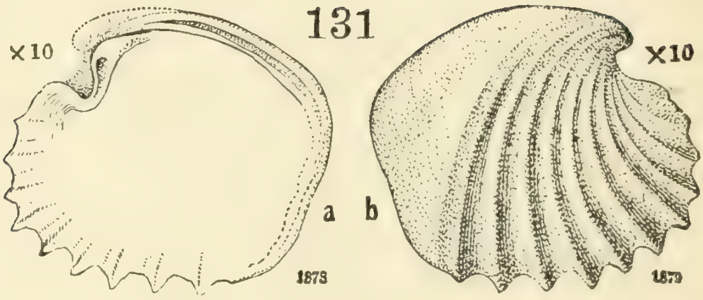
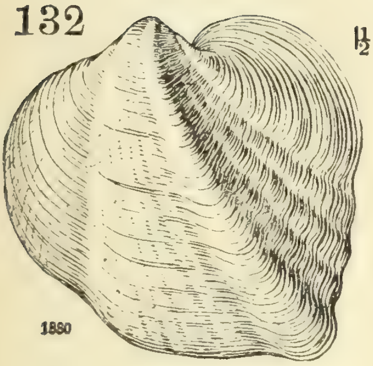


127


132


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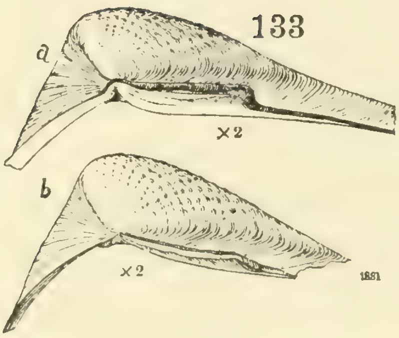

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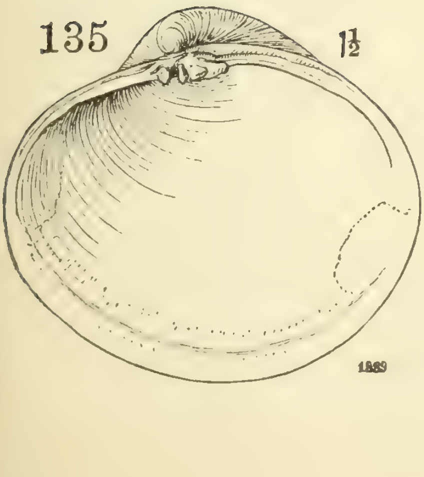

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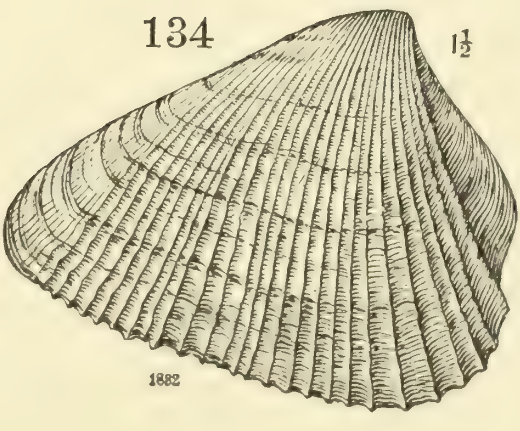


Plate XXXI.

Fig. 136. *Diplodonta turgida* V. & S. Interior view of left valve of another specimen, enlarged one and one-half diameters.

Fig. 137. *Yoldia thraciformis.* Side view of the shell and living animal in expansion, two-thirds natural size.

Fig. 138. The same. Ventral view of the shell and living animal, two-thirds natural size.

Fig. 139. *Yoldia sapotilla.* Side view of the shell and living animal in full expansion, one and one-half times natural size.

Fig. 140. *Leda acuta.* Interior of left valve, enlarged four diameters.

Fig. 141. *Pecten vitreus*, natual size.

Fig. 142. *Pecten pustulosus* V. One of the type specimens, enlarged two diameters; *a*, lower valve; *b*, upper valve of the same specimen.

Fig. 144. *Culeolus Tanneri* V. Side view of one of the type specimens, natural size; *a*, front view of the same specimen.

Fig. 145. The same. Side view of another type specimen, natural size; *b*, posterior view of the same specimen.

Figs. 144 and 145 were drawn from specimens preserved a short time in alcohol.

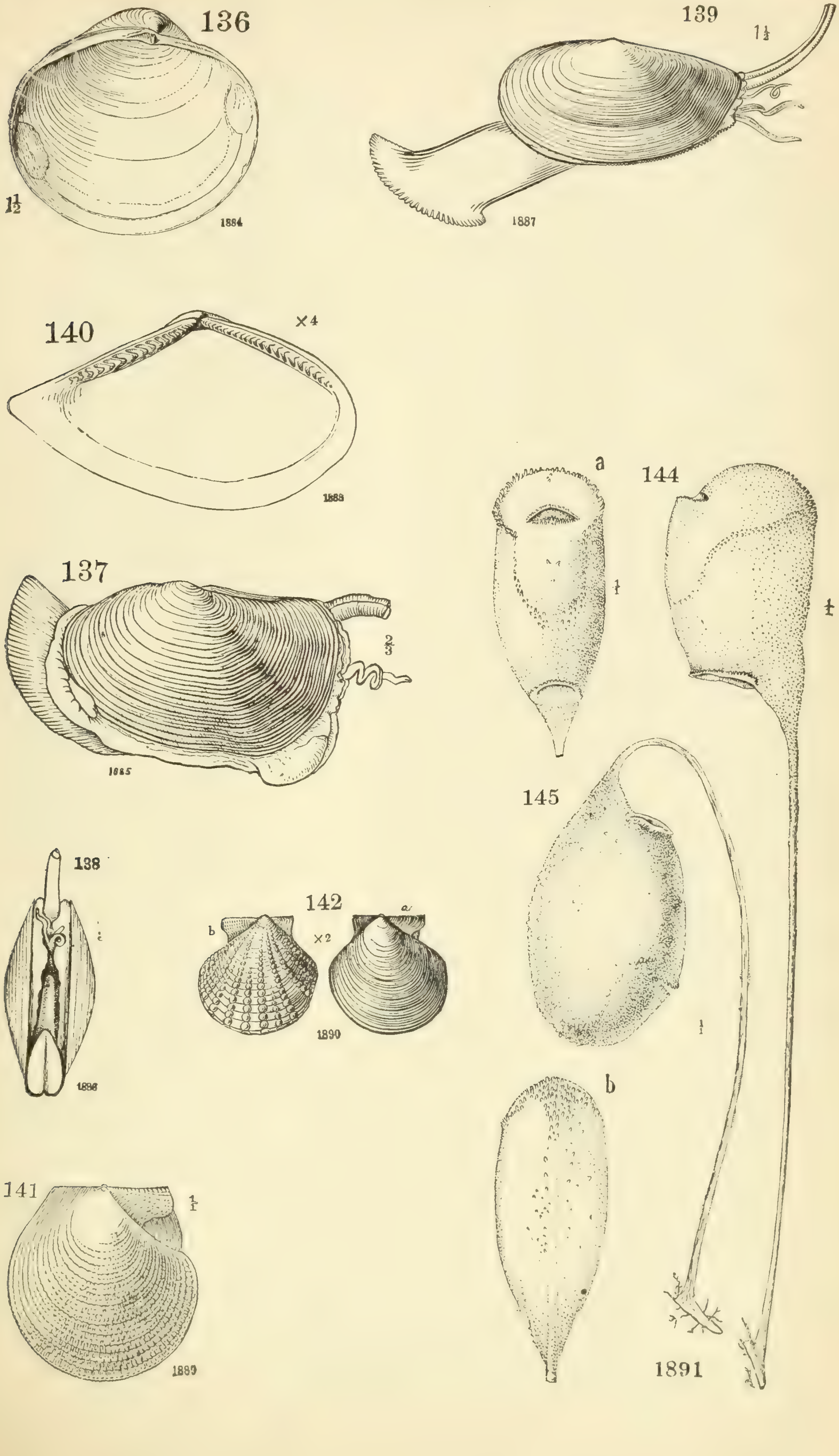

136
1½
1884
139
1½
1887
140
×4
1888
137
2/3
1885
138
1886
142
b
×2
a
1890
141
1/1
1889
a
144
145
b
1891

PLATE XXXII.

FIG. 146. *Doliolum*, sp. View of a small living specimen taken in the Gulf Stream, much enlarged.

FIG. 147. *Salpa Caboti*. Front view of a living specimen of the solitary form in which a chain is seen in process of development, enlarged three diameters; *a*, side view of the same specimen, which was taken in Vineyard Sound, August, 1884.

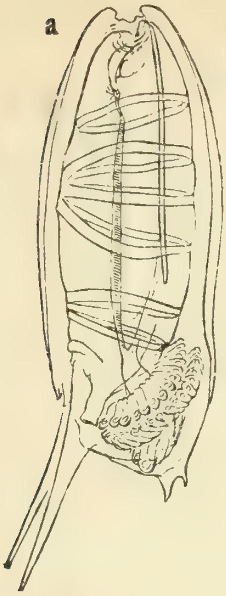
FIG. 148. *Salpa clotho* M.-Edw. Dorsal view of a small individual of the solitary form in which a young chain is seen developing, enlarged three diameters.

FIG. 149. The same. Side view of a somewhat smaller specimen, enlarged three diameters; *a*, dorsal view of another specimen, natural size.

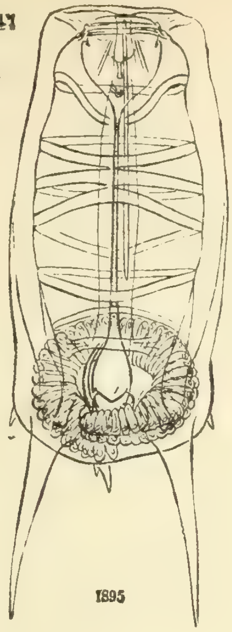
FIG. 150. The same species. One of the individuals from a chain not full grown, side view, natural size; *a*, the same specimen, front view.

Figs. 147–150 were made by J. H. Blake from living specimens taken in Vineyard Sound, August, 1884. Fig. 146 was drawn by J. H. Emerton.

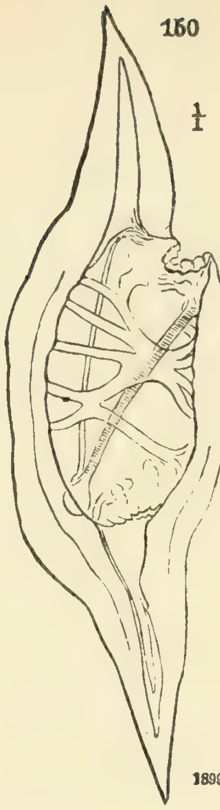
a ×3



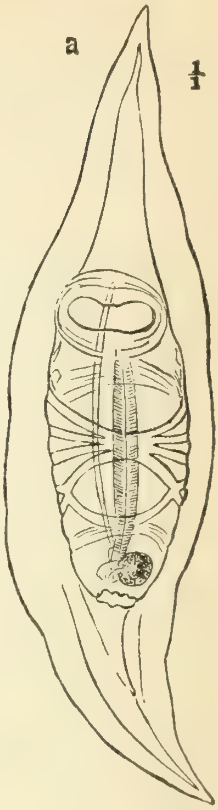
147



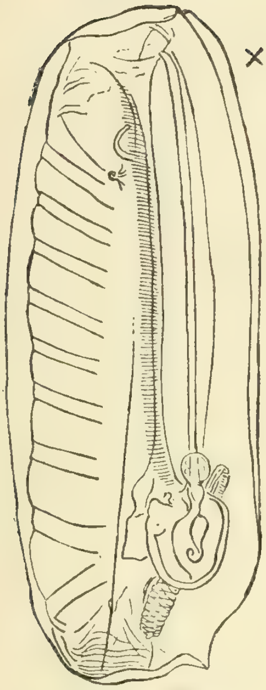
150 $\frac{1}{1}$



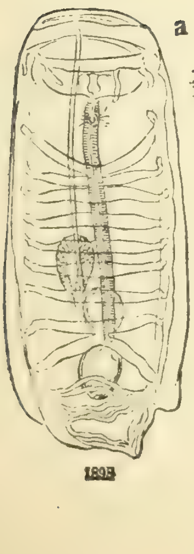
a $\frac{1}{1}$



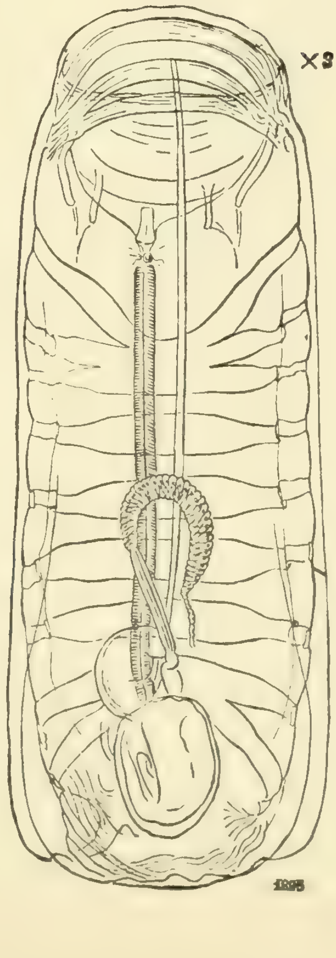
149 ×3



a $\frac{1}{1}$



148 ×3



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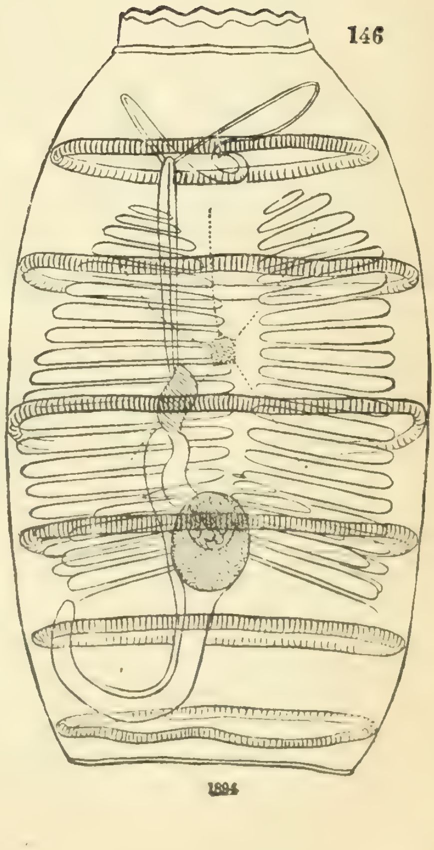


PLATE XXXIII.

FIG. 151. *Lithodes Agassizii* Smith. A small female, one-half natural size; *a*, dorsal view of a young specimen with long spines, enlarged two diameters; *b*, the same specimen, side view of the carapax.

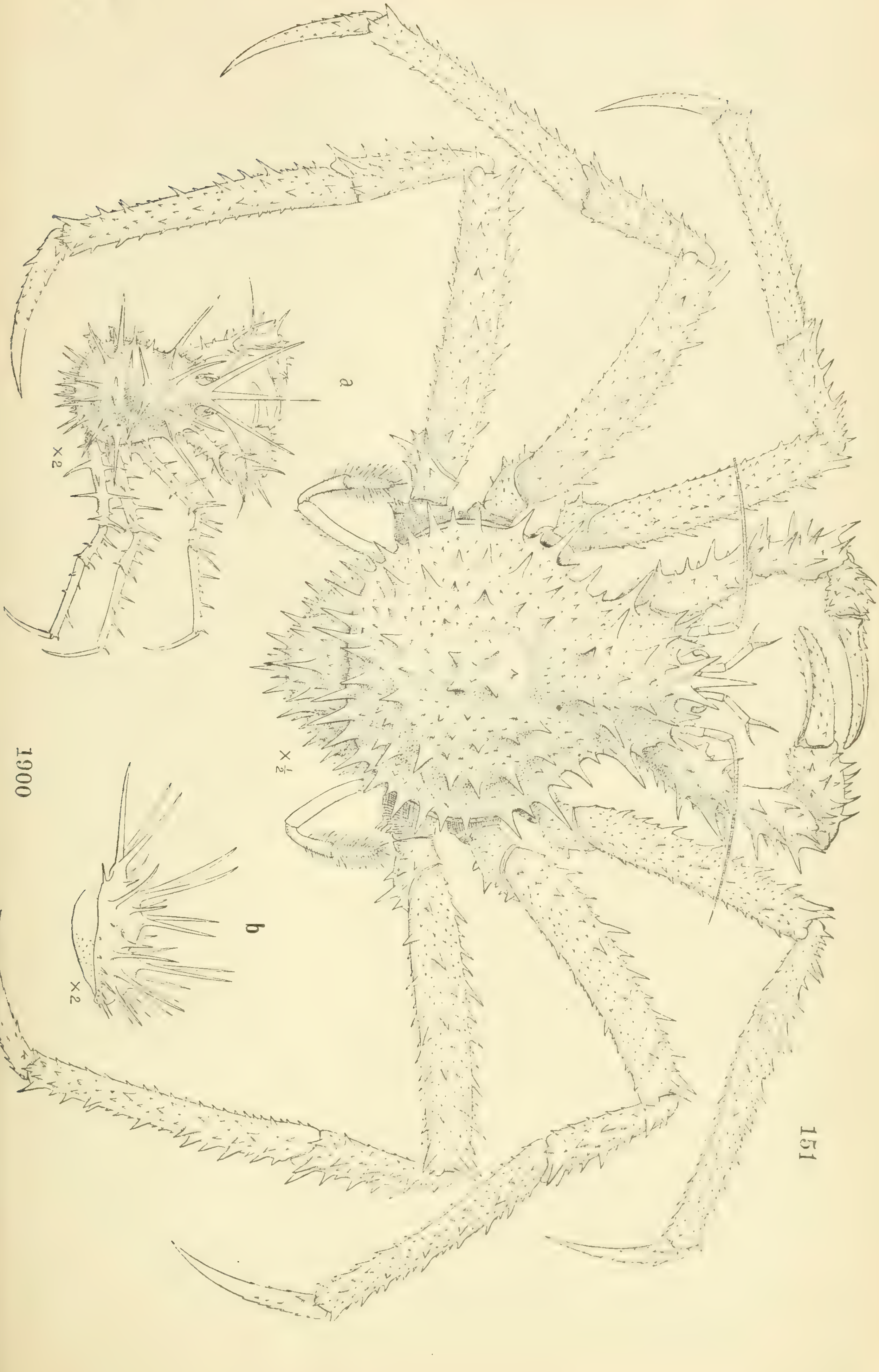

a
×2
×½
b
×2
1900
151

PLATE XXXIV.

FIG. 152. *Pentacheles sculptus* Smith. Female. Dorsal view, natural size.

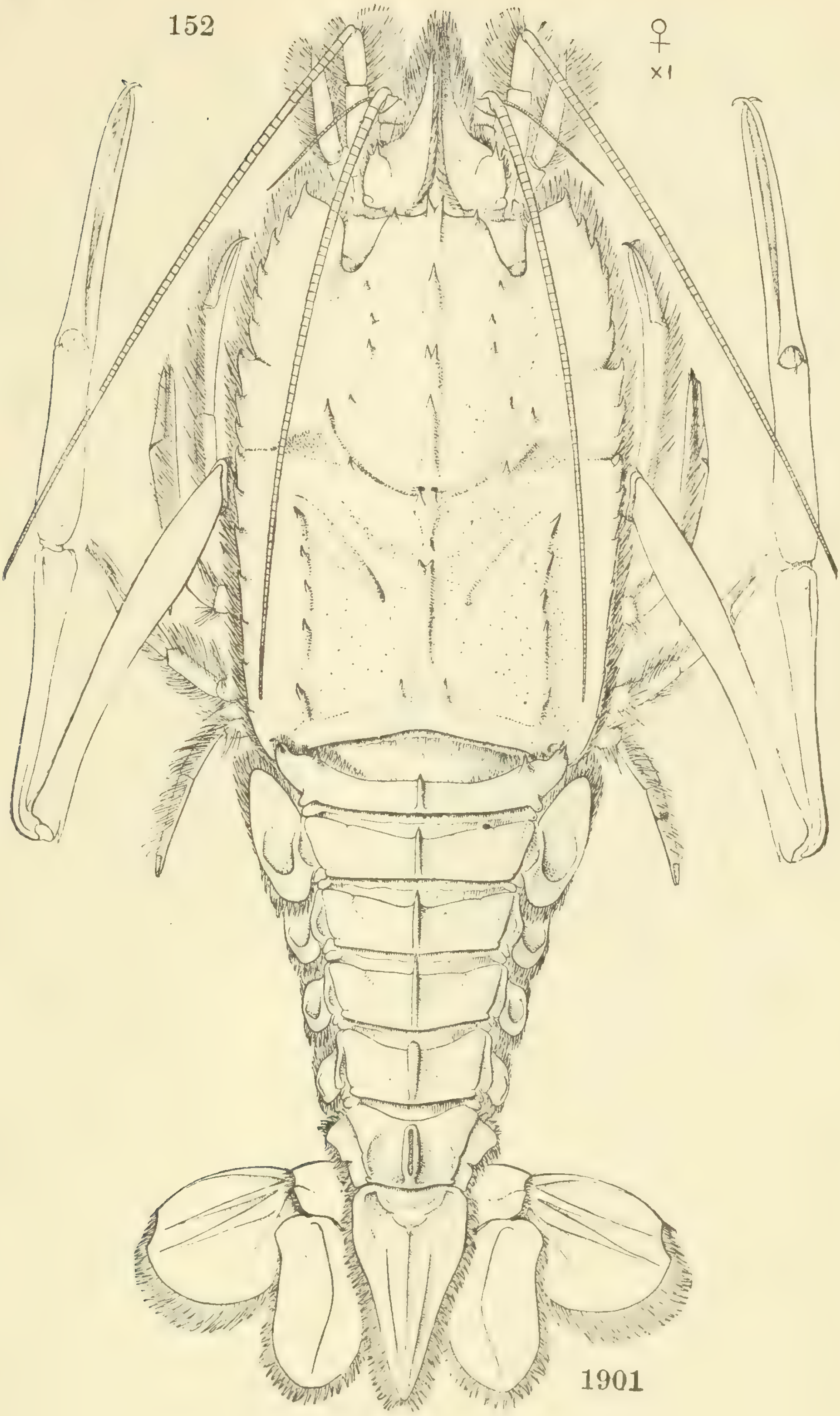
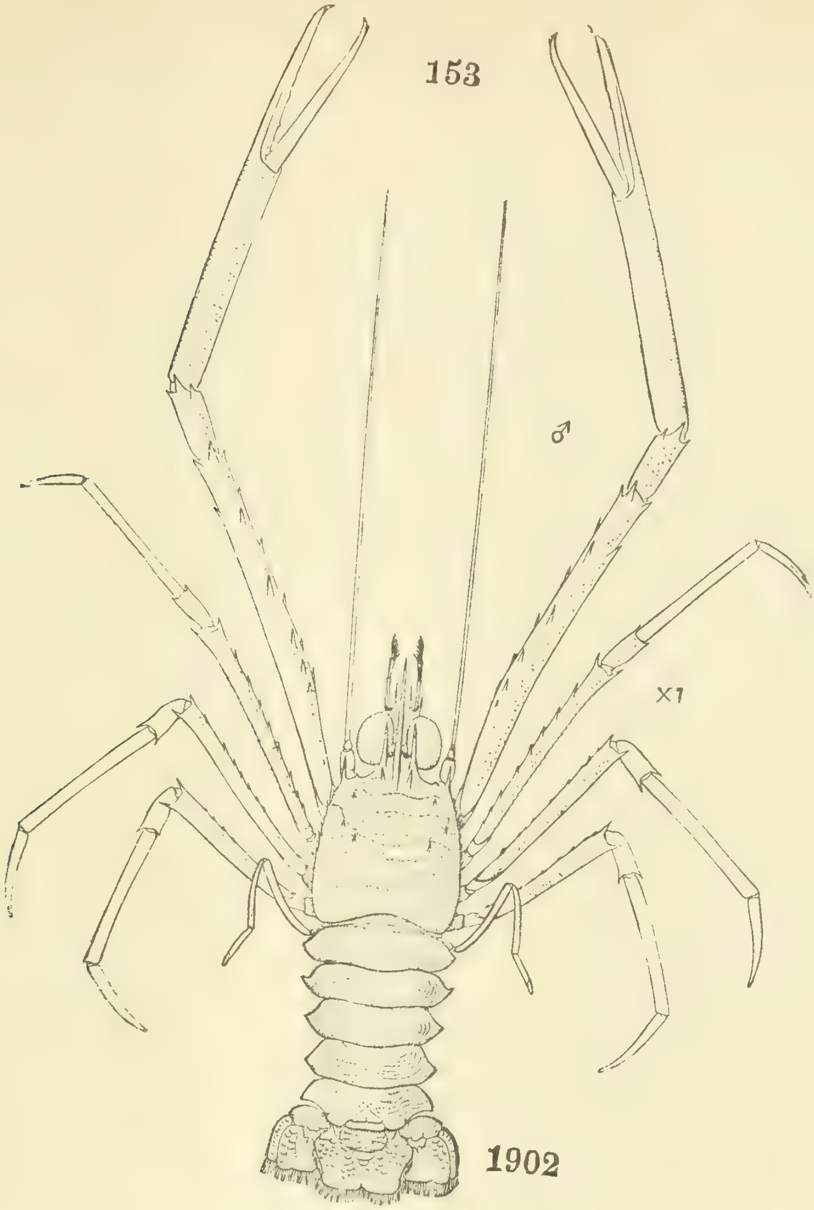

152
♀
×1
1901

PLATE XXXV.

FIG. 153. *Munida Caribœa?* Male, natural size.
FIG. 154. *Glyptocrangon sculptus* Smith. Female, natural size.

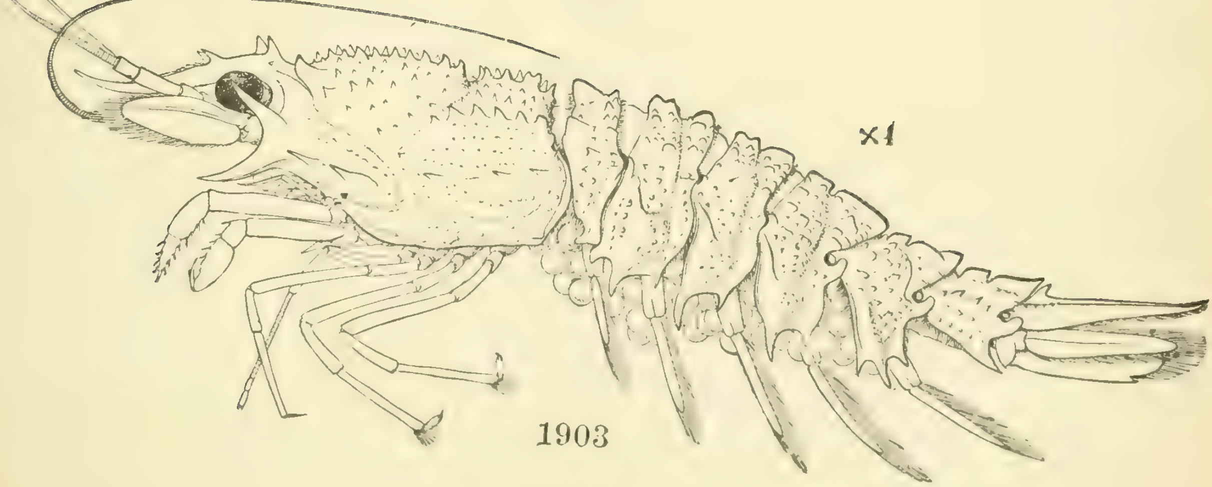
PLATE XXXV.

153



1902

154



1903

PLATE XXXVI.

FIG. 155. *Ceraphilus Agassizii* Smith. Female, natural size.

FIG. 157. *Sabinea princeps* Smith. Female with eggs, natural size.

FIG. 163. *Phronima*, sp. In a transparent case formed from the test of a large *Salpa*. Female, with young attached to the inner surface of the case, somewhat enlarged.

FIG. 164. *Sycenus infelix* Harger, enlarged one and one half diameters.

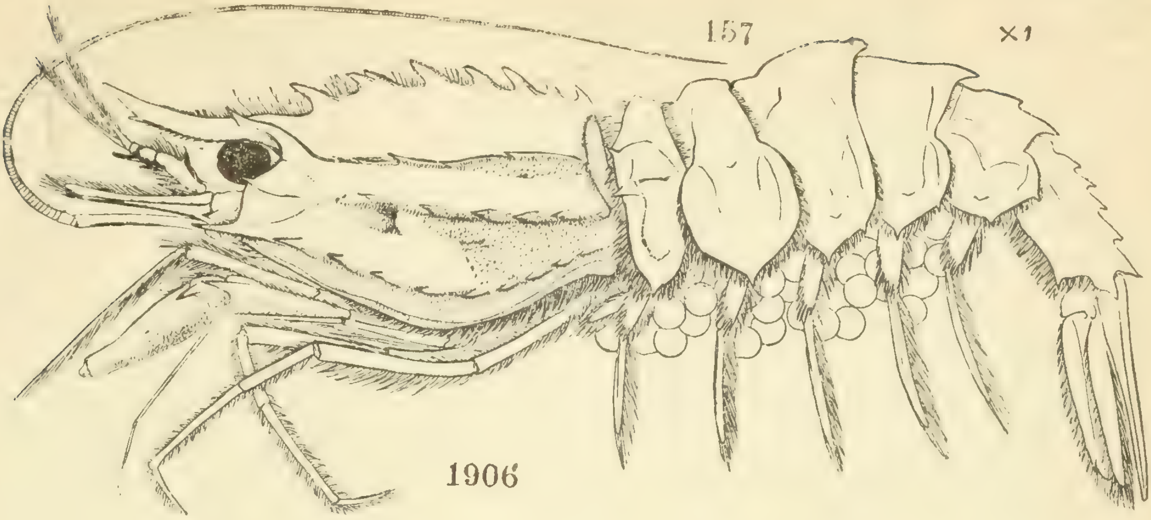
Fig. 165. *Cirolana impressa* Harger, enlarged three diameters.

FIG. 167 *Antheacheres Dubenii*. Male, natural size; *a*, dorsal; *b*, ventral view.

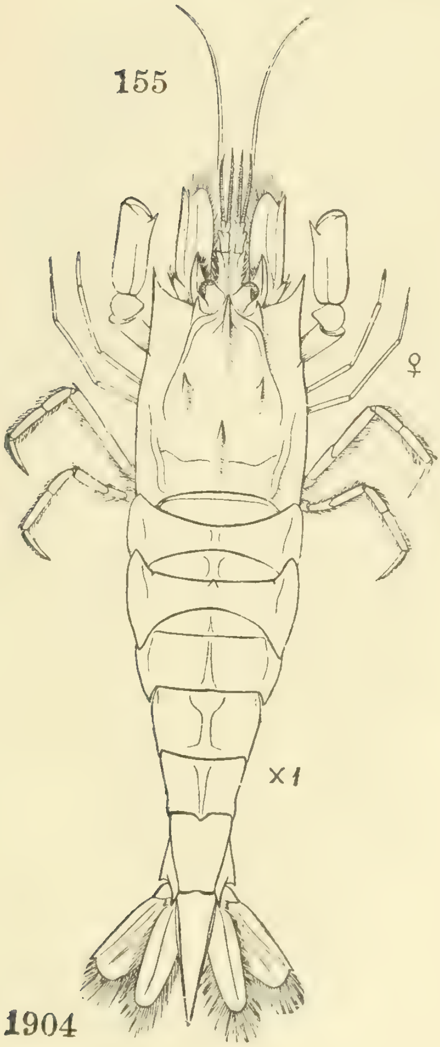
FIG. 168 The same. Female, natural size; *a*, ventral; *b*, lateral; *c*, dorsal view, with a detached egg case.

PLATE XXXVI.

157

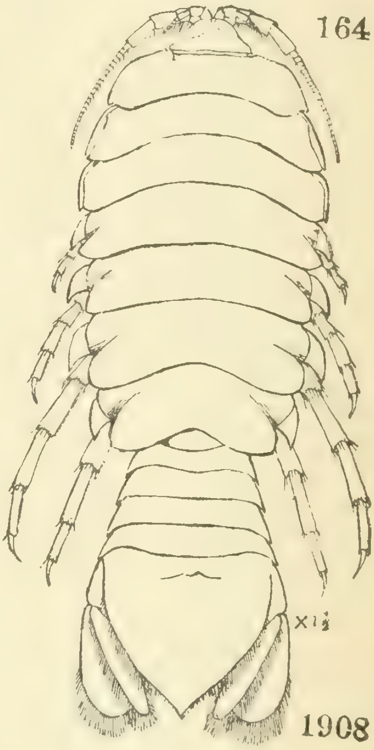


155

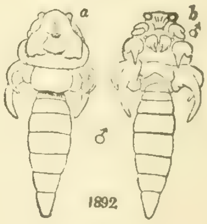


165

164



167



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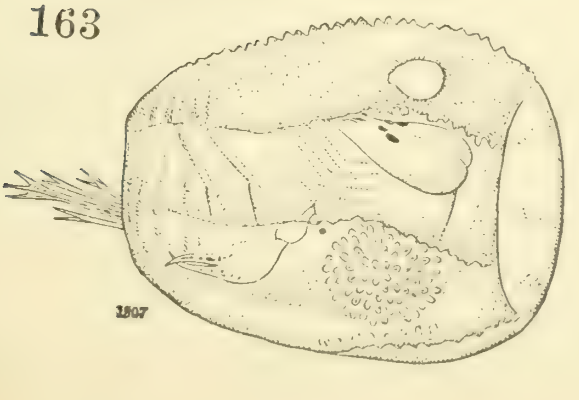

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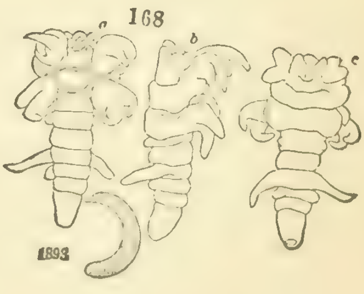


PLATE XXXVII.

FIG. 156. *Geryon quinquedens* Smith. A small male, two-thirds natural size.

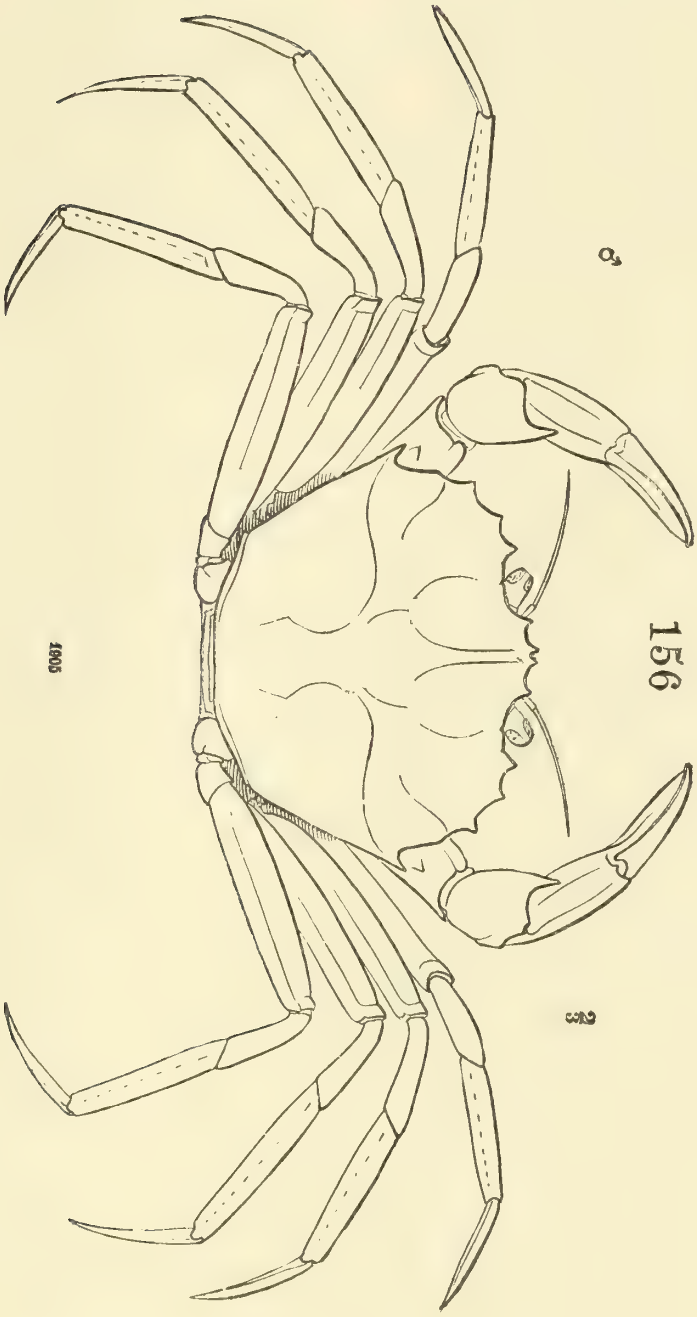
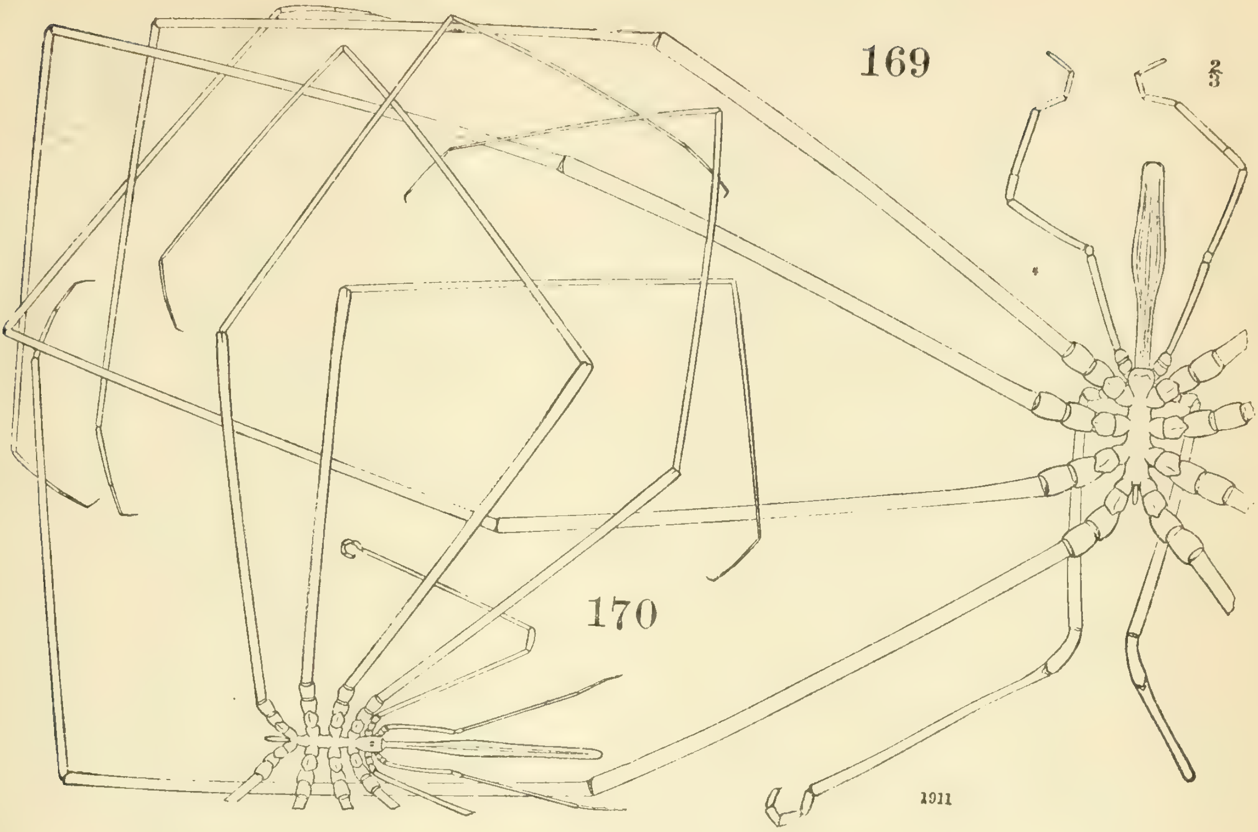

♂
156

PLATE XXXVIII.

FIG. 169. *Colossendeis collosea,* two-thirds natural size.
FIG. 170. *Colossendeis macerrima,* two-thirds natural size.
FIG. 171. *Scæorhynchus armatus.* Dorsal view, two-thirds natural size; *a,* side view of body, natural size.


169
2/3
170
1911

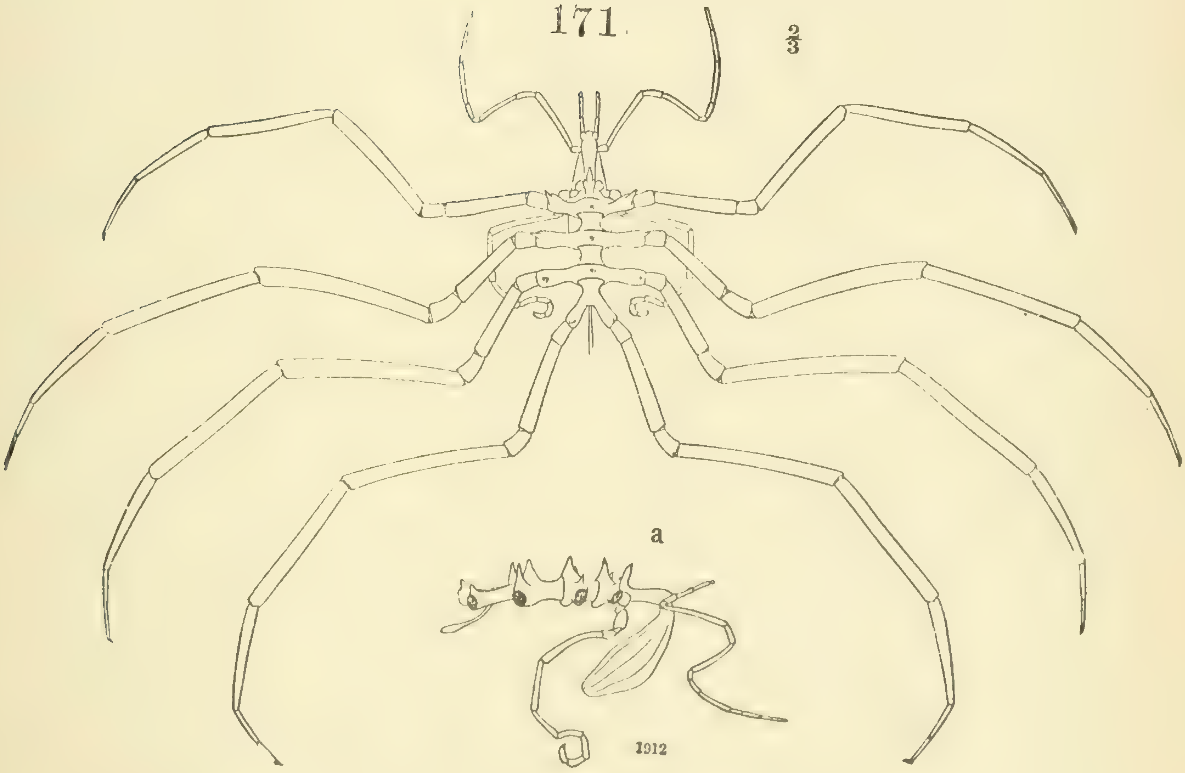

171
2/3
a
1912

PLATE XXXIX.

FIG. 172. *Polynoë Acanellæ* V. Dorsal view of the head and anterior segments, enlarged about four diameters.

FIG. 172 *a*. The same. Part of a scale, enlarged eighty diameters.

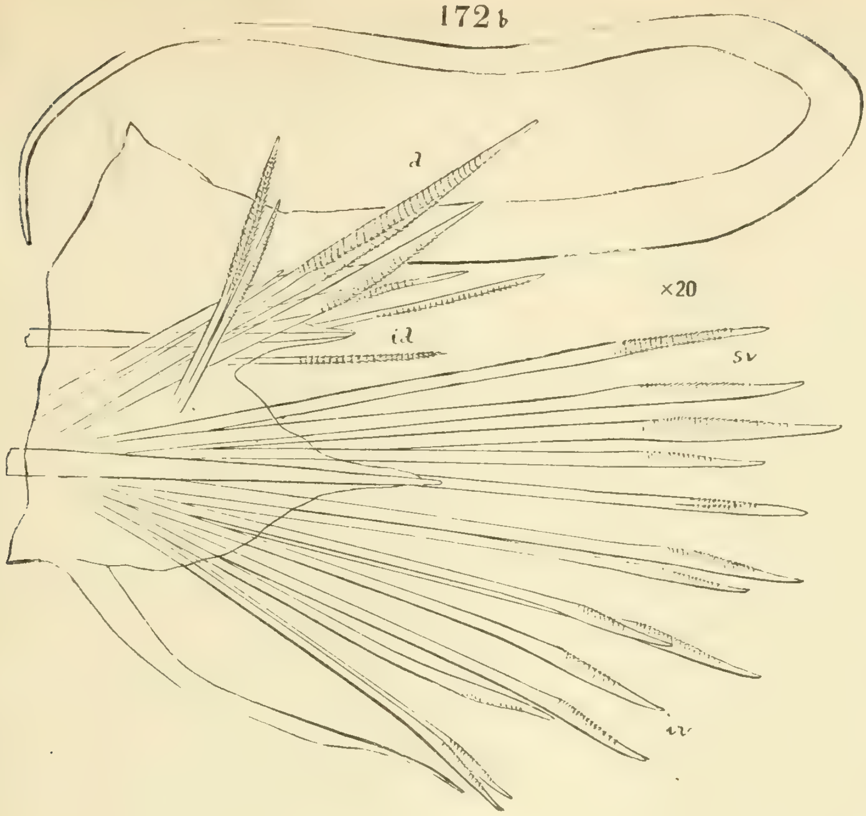
FIG. 172 *b*. The same. One of the parapodia, enlarged twenty diameters; *d*, the argel dorsal setæ; *id*, the slender dorsal setæ; *sv*, large upper setæ of the ventral fascicle; *iv*, smaller and more slender lower setæ of the ventral fascicle; *a*, tips of the dorsal setæ, enlarged eighty diameters; *b*, tip of one of the ventral setæ, enlarged eighty diameters.

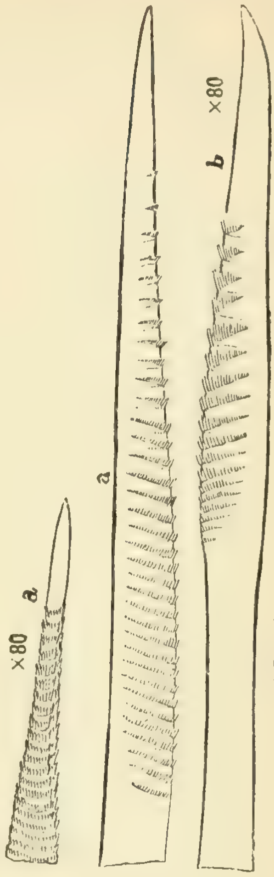
FIG. 172 *c*. The same. Portion of the spinulated part of one of the dorsal setæ to show the character of the spinules and longitudinal furrow, enlarged two hundred and fifty diameters.

FIG. 176. *Lætmatonice armata* V. Head and anterior segments. Dorsal view, enlarged six diameters. Three anterior scales have been removed to show the head; *a*, median antenna, *c*, *c'*, dorsal cirri of the first pair of parapodia; *p*, tentacular or ventral cirrus of the same parapodia; *vc*, ventral cirrus of the second parapodia; *dc*, dorsal cirrus of the third, and *dc'*, of the sixth parapodia; *ds*, slender dorsal setæ; *ds*, stout dorsal setæ; *vs*, ventral setæ; *h*, head or cephalic lobe; *e*, papilla from which the anterior scale has been removed; *e''* and *e'''*, second and third pairs of scales.

FIG 176 *a*. The same. Setæ enlarged fifteen diameters; *d* and *d'*, the tips of the stout spine-like dorsal setæ; *ds*, a group of ventral setæ; *vc*, ventral cirrus.

172 b

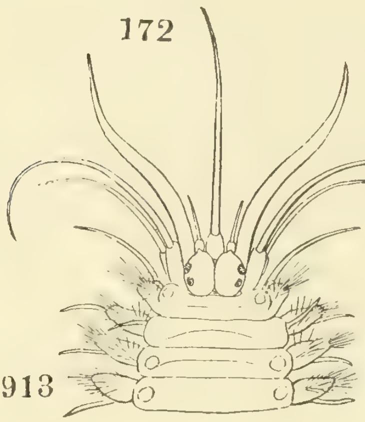




1915

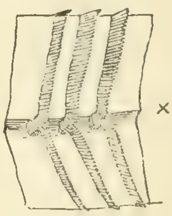
×80 1914

172



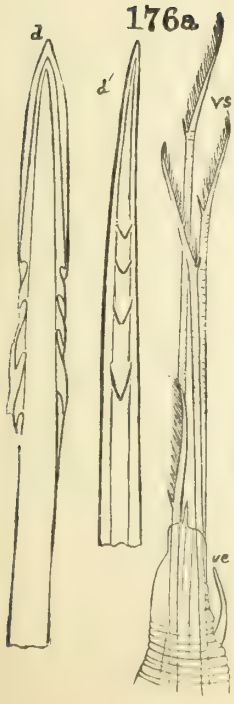
1913

172 c

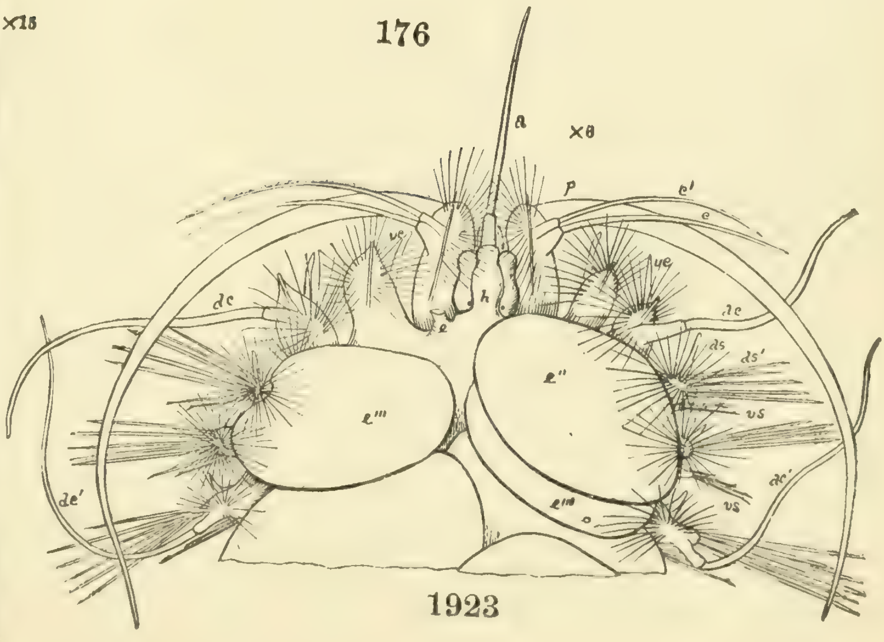


1916

176a



176



1923

PLATE XL.

FIG. 173. *Polynoë aurantiaca* V. One of the parapodia, enlarged fifteen diameters; *dc*, dorsal cirrus; *d*, small dorsal lobe, which is destitute of setæ; *v*, ventral lobe; *sv*, superior ventral setæ; *iv*, large inferior ventral setæ; *a*, one of the superior ventral setæ, enlarged eighty diameters.

FIG. 173 *a*. The same. One of the scales, enlarged four diameters.

FIG. 174. *Polynoë* (*Harmothoë*) *imbricata*. Dorsal view, enlarged two diameters.

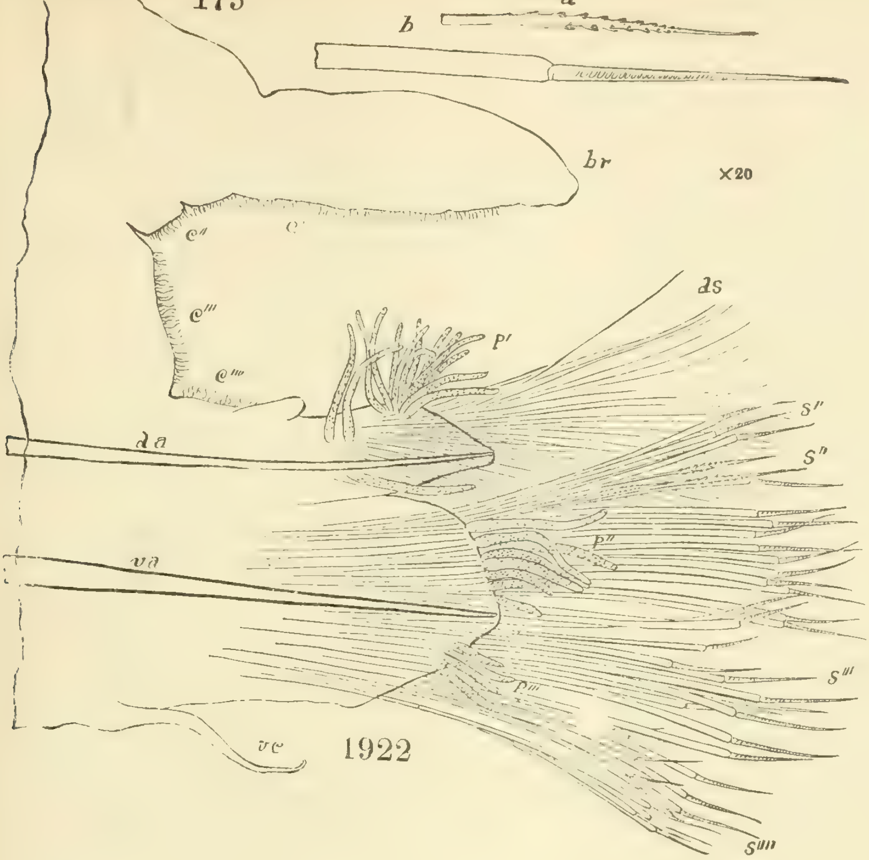
FIG. 174 *a*. The same. Part of a scale, enlarged thirty diameters.

FIG. 174 *b*. The same. Setæ, enlarged forty diameters; *d*, one of the stout dorsal setæ; *v*, *v'*, ventral setæ.

FIG. 175. *Leanira robusta* V. One of the parapodia, enlarged twenty diameters; *br*, branchial lobe of the dorsal side; *e'*, *e''*, *e'''*, line of cilia occupying the space between the branchial and setigerous lobes; *p'*, slender papillæ of the dorsal branch; *p''*, *p'''*, similar appendages of the ventral branch; *vc*, ventral cirrus; *da*, aciculum of the dorsal branch; *va*, aciculum of the ventral branch; *ds*, dorsal setæ; *s'*, *s''*, *s'''*, *s''''*, various forms of setæ of the ventral branch; *a*, tip of one of the slender simple setæ; *b*, tip of one of the compound ventral setæ, much more enlarged.

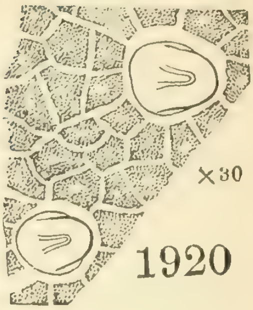
FIG. 184. *Notophyllum Americanum* V. Head and anterior segments, enlarged eight diameters; *a*, posterior end of the same specimen.

175



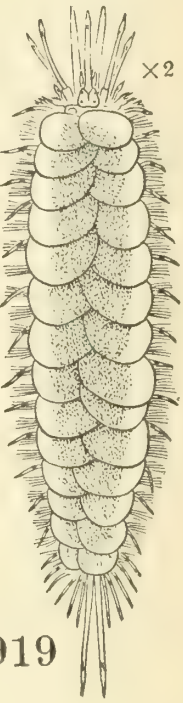
1922

174 a



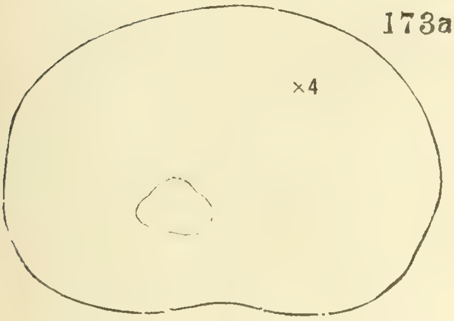
1920

174



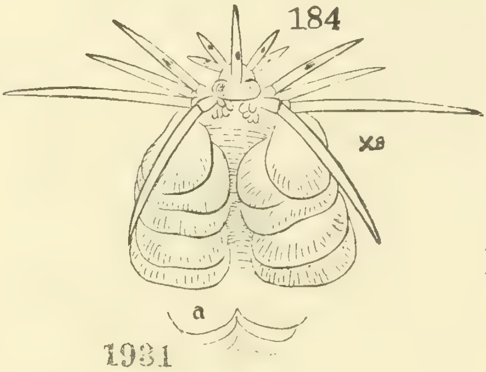
1919

173a



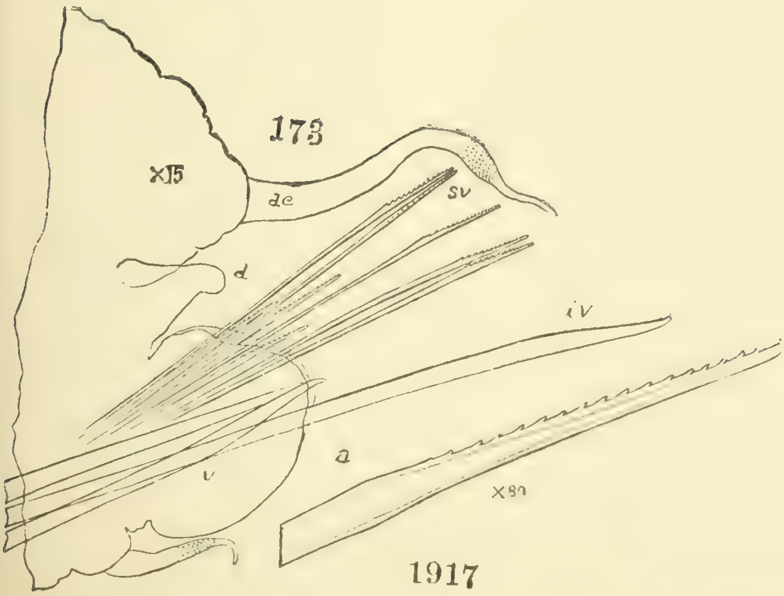
1918

184



1931

173



1917

174 b

1921

Plate XLI.

Fig. 178. *Hyalinœcia artifex* V. Head and anterior segments, enlarged about one and one-half diameters; *b*, the same, ventral view of the head and anterior segments of another specimen, enlarged about one and one-half diameters; *c*, the same, posterior segments and caudal cirri, enlarged five diameters.

Fig. 178 *a*. The same. Ventral view of the head and anterior segments, enlarged three diameters.

Fig. 179. The same. One of the anterior parapodia, enlarged thirty diameters; *b*, branchia; *c*, dorsal cirrus; *a*, one of the parapodia from a segment farther back, destitute of the branchia, enlarged thirty diameters; *c*, dorsal cirrus; *b*, one of the funnel-shaped setæ, enlarged seventy-five diameters; *e*, the same, enlarged three hundred and seventy-five diameters; *c*, a seta with bilobed tip, enlarged seventy-five diameters; *d*, spiniform seta, enlarged seventy-five diameters.

Fig. 180. *Leodice polybranchia* V. One of the parapodia, enlarged twenty diameters; *a*, tip of one of the compound setæ, enlarged one hundred diameters; *b*, tip of one of the funnel-shaped setæ, enlarged two hundred diameters.

Fig. 181. *Nothria conchyphila* V. Dorsal view of head and anterior segments, enlarged eight diameters.

PLATE XLI.

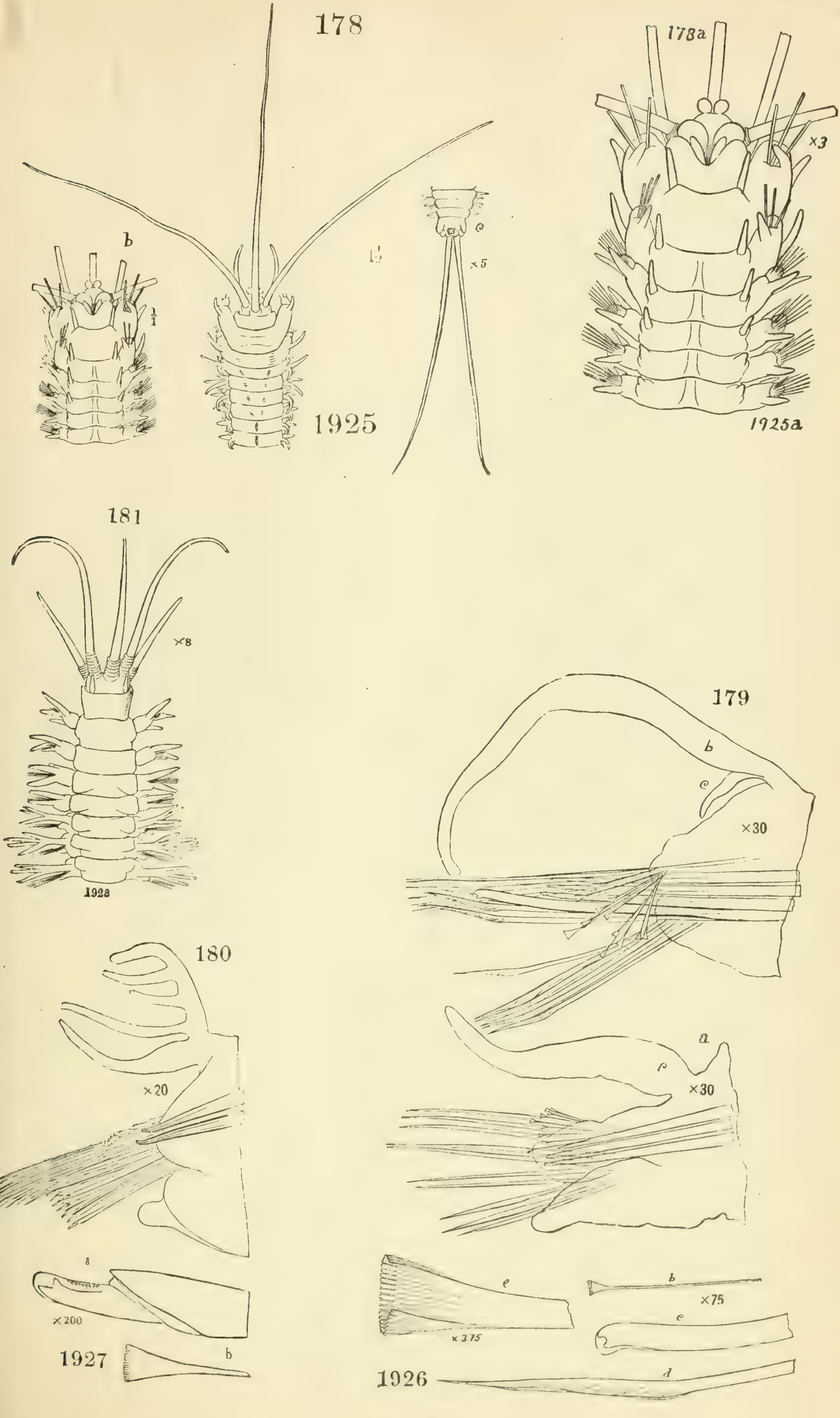

178
178a
×3
b
1/1
1925
1925a
×5
181
×8
1928
179
b
×30
a
×30
180
×20
×200
b
1927
e
×375
b
×75
d
1926

PLATE XLII.

FIG. 182. *Amphinome Lepadis* V. Head and anterior segments, enlarged six diameters; *a*, posterior extremity of the same specimen; *b*, one of the branchiæ.

This specimen was found among stems of *Lepas*, on floating timber, in the Gulf Stream.

FIG. 183. *Syllis spongiphila* V. Dorsal view of the head and anterior segments, enlarged twenty-four diameters; *a*, one of the compound setæ, enlarged seven hundred and fifty diameters.

FIG. 185. *Ophioglycera grandis* V. Head, enlarged four diameters.

FIG. 185 *a*. The same. One of the parapodia from the anterior region; *b*, one of the parapodia from the middle region of the body. From a specimen taken at the surface in Newport Harbor.

FIG. 188. *Sabella picta* V. Anterior segments and base of branchiæ, ventral view, enlarged four diameters; *c*, the same, posterior segments; *d*, one of the branchiæ.

FIG. 188 *a*. The same. One of the hook-shaped setæ, enlarged one hundred diameters; *b*, one of the spatulate setæ, enlarged one hundred diameters.

FIG. 189. *Vermilia serrula*. Dorsal view of the tube and expanded branchiæ; *o*, side view of operculum; *o*, operculum of another specimen, with adherent dirt.

FIG. 190. *Maldane biceps*. *a*, anterior portion, side view, enlarged four diameters; *b*, posterior portion, side view, enlarged two diameters.

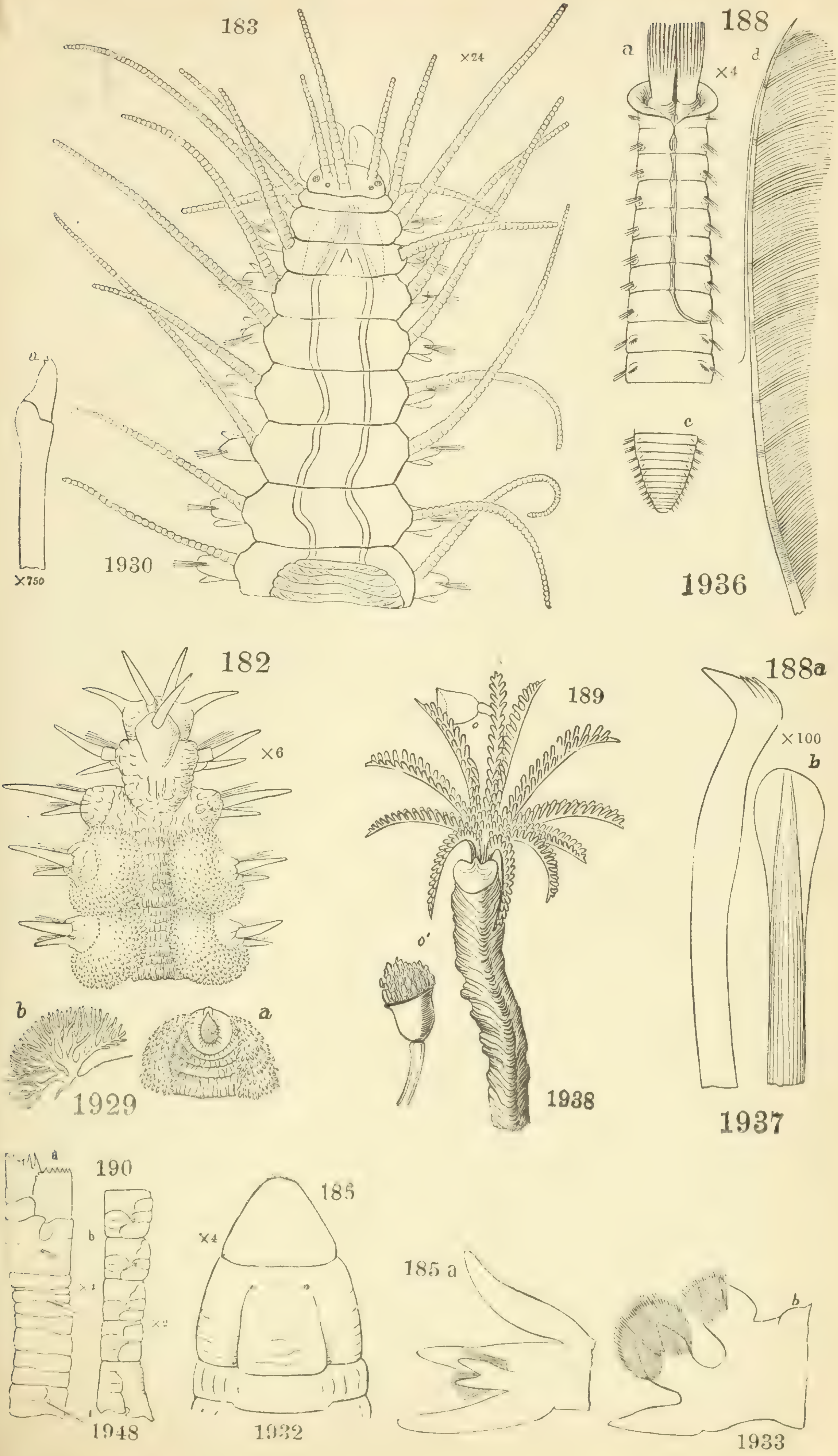

183
×24
a
×750
1930
188
a
×4
d
c
1936
182
×6
b
a
1929
189
o'
1938
188a
×100
b
1937
190
a
b
×1
×2
1948
185
×4
1932
185 a
b
1933

PLATE XLIII.

FIG. 186. *Dipolydora concharum* V. Dorsal view of the head and anterior segments, enlarged sixteen diameters; *a*, caudal segments.

FIG. 187. *Lepræa abyssicola* V. Side view, natural size.

FIG. 187 *a*. The same. Side view of the head and anterior segments, enlarged three diameters; *b*, one of the uncini, enlarged three hundred diameters.

FIG. 191. *Priapulus*, sp., natural size.

FIG. 191 *a*. The same. Front view of the anterior end, enlarged two diameters.

FIG. 192. *Phascolosoma*, sp., natural size; *a*, the same, ventral view of the anterior end; *d*, one of the openings of the segmental organs.

FIG. 193. *Tristoma cornutum* V. Ventral view, enlarged four diameters. From a bill-fish. Type specimen, drawn from life.

FIG. 194. *Tristoma læve* V. Ventral view, enlarged four diameters. From a bill-fish. Type specimen, drawn from life.

FIG. 195. *Cerebratulus luridus* V. One-half natural size. Drawn from life.

FIG. 196. *Sagitta gracilis* V. Dorsal view, enlarged four diameters.

FIG. 196*a*. The same. Dorsal view of the head, enlarged ten diameters. From a specimen taken at Wood's Holl, at the surface.

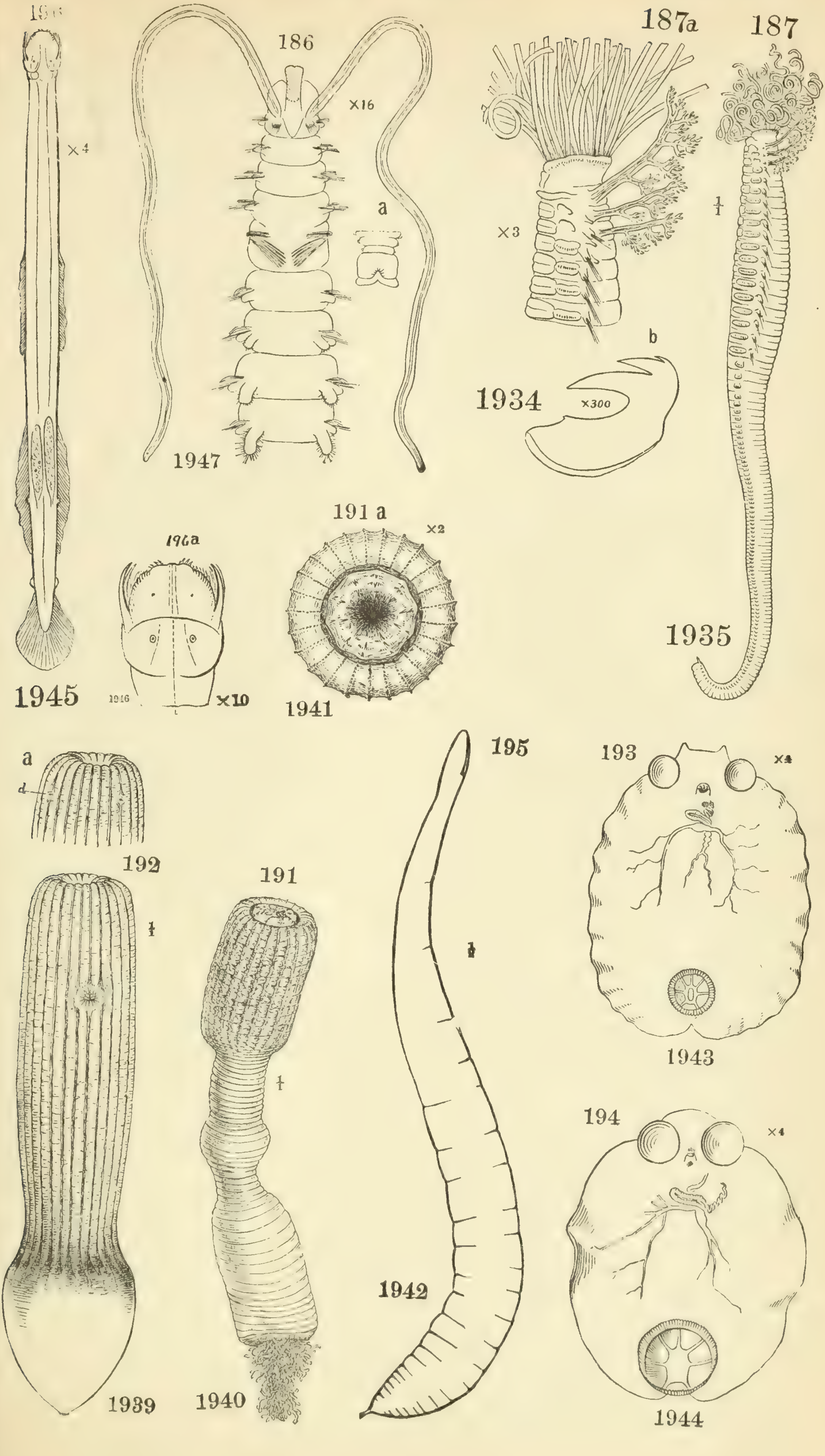

186
×16
a
1947
×4
1945
196a
1946
×10
191 a
×2
1941
187a
×3
1934
b
×300
187
1935
a
d
192
1939
191
1940
195
1942
193
×4
1943
194
×4
1944

PLATE XLIV.

FIG. 25. *Sagartia Acanellæ* V. Side view of a partially expanded specimen surrounding a branch of *Acanella Normani* by its clasping base; *a*, the prolongation of the base toward the tip of the branch; *b*, a smaller extension of the base in the opposite direction, enlarged two diameters.

FIG. 177. *Sagartia abyssicola* V., on a tube of *Hyalinœcia artifex* V., somewhat less than natural size; *a*, an individual in full expansion; *b*, one partially contracted; *c*, one in expansion, showing the protruded acontia; *d*, the head and anterior part of the *Hyalinœcia* protruded from its tube, side view; *k*, ventral view of the same, with the antennæ cut off near their bases. Drawn from life.

FIG. 197. *Cladorhiza grandis* V., two-thirds natural size.

FIG. 198. *Acanella Normani*. Part of a branch with the axis denuded to show the arrangement of the branchlets in whorls, natural size; *a*, the same, a group of calicles from the tip of a branch with the tentacles partly expanded. Drawn from a living specimen; *v*, several forms of spiculæ, enlarged twenty diameters.

PLATE XLIV.

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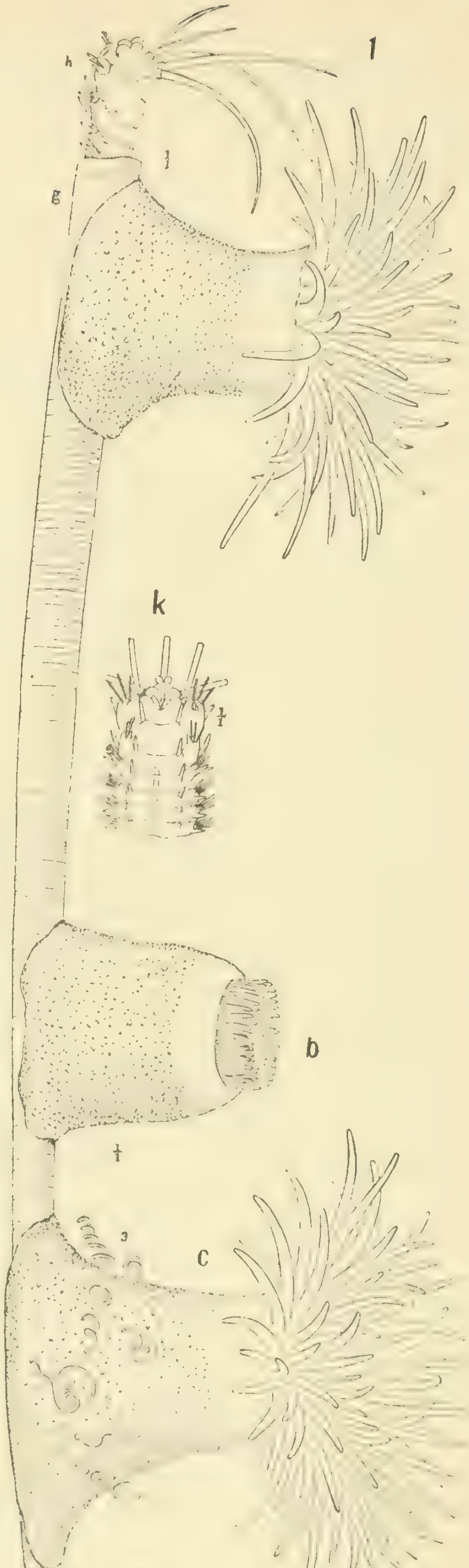

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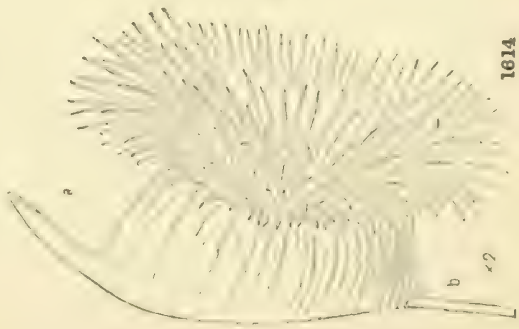

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XVII.—LIST OF DEEP-WATER MOLLUSCA DREDGED BY THE UNITED STATES FISH COMMISSION STEAMER FISH HAWK IN 1880, 1881, AND 1882, WITH THEIR RANGE IN DEPTH.

By KATHARINE J. BUSH.

The following list is intended to include all the Mollusca dredged by the Fish Hawk in the region of the Gulf Stream that have been determined.* In general only those species that have been taken below 60 fathoms are included, except the surface species inhabiting the same region.

References are given to descriptions and figures of those species not contained in Binney's edition of Gould's Invertebrata of Massachusetts, but no complete synonomy is attempted.

The bathymetrical range includes all stations between the southern slope of George's Bank on the north and the region off Chesapeake Bay on the south, unless otherwise stated. Many of the species occur farther north, and in such cases frequently in shallower water than here indicated, but no attempt has been made to show the entire distribution, except in a few instances where the vertical range is given for the specimens taken north of Cape Cod by the Fish Commission, and in the Cephalopods, where some of the "Blake Expedition" specimens are included. The later dredgings of the Albatross, in 1883, have in many cases increased the vertical range of the species and added many others to the fauna.

The sign (*) indicates that the specimens were taken alive; those that were dead are designated by a dagger (†); when no special mark is given the specimens were living.

CEPHALOPODA.

DECACERA.

Lestoteuthis Fabricii (Licht.) Verrill.

> *Gonatus Fabricii* Verrill, Trans. Conn. Acad., vol. v, p. 291, 1881.
>
> *Lestoteuthis Fabricii* Verrill, Trans. Conn. Acad., vol. v, p. 390, pl. 45, figs. 1–2*d*; pl. 49, figs. 1–1*f*; pl. 55, figs. 1–1*d*, 1881.

Range, 255–724 fathoms; northern, in shallow water.

* The number of undetermined species is not large. They are mostly young, or small species belonging to *Turbonilla*, *Bullidæ*, *Yoldia*, *Cryptodon*, *Montacuta*, &c., or else larger specimens too much eroded for accurate identification.

Abralia megalops Verrill.

Amer. Journ. Sci., vol. xxiv, p. 364, Nov., 1882; Bull. Mus. Comp. Zool., vol. xi, p. 105, pl. 3, fig. 4, 1883; Trans. Conn. Acad., vol. vi, pl. 28, fig. 2, 1884.

Range, 173 fathoms; Blake Exp., 137 fathoms, West Indies.

Ommastrephes illecebrosus (Les.) Verrill.

Trans. Conn. Acad., vol. v, pp. 268, 403, pl. 28; pl. 29, figs. 5, 5*a*; pl. 37, fig. 8; pl. 38, fig. 2; pl. 39, figs. 2–3*b*, 1880 and 1881.

Range, shore to 640 fathoms.

Chiroteuthis lacertosa Verrill.

Chiroteuthis Bonplandi Verrill, Trans. Conn. Acad., vol. v, p. 229, 1881.
Chiroteuthis lacertosa Verrill, Trans. Conn. Acad., vol. v, p. 408, pl. 47, figs. 1–1*b*; pl. 55, fig. 5; pl. 56, figs. 1–1*f*, 1881.

Range, 435 fathoms.

Brachioteuthis Beanii Verrill.

Trans. Conn. Acad., vol. v, p. 406, pl. 55, figs. 3–3*b*; pl. 56, figs. 2, 2*a*, 1881.

Range, 183–368 fathoms.

Calliteuthis reversa Verrill.

Trans. Conn. Acad., vol. v, p. 295, pl. 46, figs. 1–1*b*, 1881; vol. vi, p. 243, 1884.

Range, 365 fathoms.

Histioteuthis Collinsii Verrill.

Trans. Conn. Acad., vol. v, p. 234, pl. 22, Feb., 1879; pp. 300, 404, pl. 27, figs. 3–5; pl. 37, fig. 5; pl. 55, figs. 6, 6*a*, 1881.

Range, 372 fathoms +.

Desmoteuthis tenera Verrill.

Trans. Conn. Acad., vol. v, p. 412, pl. 55, figs. 2–2*d*; pl. 56, fig. 3, 1881.

Range, 396 fathoms.

Stoloteuthis leucoptera Verrill.

Sepiola leucoptera Verrill, Trans. Conn. Acad., vol. v, p. 347, 1881.
Stoloteuthis leucoptera Verrill, Trans. Conn. Acad., vol. 5, p. 418, pl. 31, figs. 4, 5; pl. 54, fig. 4, 1881.

Range, 182–640 fathoms; north of Cape Cod, 94–122 fathoms.

Rossia megaptera Verrill.

Trans. Conn. Acad., vol. v, p. 349, pl. 38, fig. 1; pl. 46, fig. 6, 1881; vol. vi, p. 245, 1884.

Range, 640 fathoms.

Rossia Hyatti Verrill.

Trans. Conn. Acad., vol. v, p. 351, pl. 27, figs. 8, 9; pl. 30, fig. 1; pl. 31, figs. 1, 2; pl. 46, fig. 5, 1881.

Range, 317? fathoms; east and north of Cape Cod, 42–101 fathoms.

Rossia sublevis Verrill.

Trans. Conn. Acad., vol. v, pp. 354, 419, pl. 30, fig. 2 ♀; pl. 31, fig. 3 ♀; pl. 46, fig. 4; pl. 47, figs. 2, 3 ♀, 4 ♂ (variety), 1881.

Range, 115–640 fathoms; north of Cape Cod, 45–110 fathoms.

Heteroteuthis tenera Verrill.

Trans. Conn. Acad., vol. v, pp. 357, 419, pl. 46, figs. 2–3*b*; pl. 47, figs. 5–5*b*, 1881.

Range, 18–301 fathoms (317 fathoms, eggs).

OCTOPODA.

Argonauta argo Linné.

Verrill, Trans. Conn. Acad., vol. 5, pp. 364, 420, 1881; vol. vi, p. 247, pl. 28, figs. 1–1*b*, 1884.

Range, 64–487 fathoms.† Surface.*

Alloposus mollis Verrill.

Trans. Conn. Acad., vol. v, pp. 366, 420, pl. 50; pl. 51, figs. 3, 4, 1881; vol. vi, p. 247, 1884.

Range, 238–724 fathoms; Blake Exp., 197 fathoms.

Octopus Bairdii Verrill.

Trans. Conn. Acad., vol. v, pp. 368, 421, pl. 33, figs. 1, 1*a*; pl. 34, figs. 5, 6; pl. 36, fig. 10; pl. 38, fig. 8; pl. 49, figs. 4, 4*a*; pl. 51, figs. 1, 1*a* (variety), 1881.

Range, 85–640 fathoms; east and north of Cape Cod, 28–110 fathoms.

Eledone verrucosa Verrill.

Trans. Conn. Acad., vol. v, p. 380, pls. 52, 53, 1881; vol. vi, p. 248, 1884.

Range, 787 fathoms; Blake Exp., 466–810 fathoms.

GASTEROPODA.

TOXOGLOSSA.

Pleurotoma Dalli Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 451, pl. 57, figs. 1, 1*a*, 1882.

Range, 94–120 fathoms*; 136–146 fathoms†.

Pleurotoma Carpenteri Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 452, pl. 57, fig. 2, 1882.

Range, 86 fathoms†; 100–155 fathoms*.

Pleurotoma comatotropis Dall.

Pleurotoma (Mangilia) comatotropis Dall, Bull. Mus. Comp. Zool., vol. ix, p. 58, 1881.

Pleurotoma comatotropis Verrill, Trans. Conn. Acad., vol. v, p. 452, 1882.

Range, 100 fathoms†.

Daphnella limacina Dall.

Pleurotoma (Bela) limacina Dall, Bull. Mus. Comp. Zool., vol. ix, pp. 55, 102, 1881.

Daphnella limacina Verrill, Trans. Conn. Acad., vol. v, p. 452, 1882.

Range, 368 fathoms.

Pleurotomella Packardii Verrill.

Amer. Journ. Sci., vol. v, p. 15, Jan., 1873; Trans. Conn. Acad., vol. v, p. 453, pl. 43, fig. 9; pl. 57, fig. 5, 1882.

Range, 193 fathoms †; north of Cape Cod, 85–110 fathoms.

Pleurotomella Agassizii Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. 5, p. 454, pl. 57, figs. 3, 3*a*, 1882.

Range, 39–787 fathoms.

Pleurotomella Pandionis Verrill.

Trans. Conn. Acad., vol. v, p. 456, pl. 57, figs. 4, 4*a*, 1882.

Range, 238–310 fathoms †; 319 fathoms *.

Gymnobela hebes Verrill.

Trans. Conn. Acad., vol. v, p. 459, pl. 57, fig. 7, 1882.

Range, 252–487 fathoms.

Bela (?) *tenuilirata* Dall.

Dall, Amer. Journ. Conch., vol. vii, p. 98, 1871.

Verrill, Trans. Conn. Acad., vol. v, p. 463, 1882.

Range, 365 fathoms †.

Bela pygmæa Verrill.

Trans. Conn. Acad., vol. v, p. 460, pl. 57, fig. 8, 1882.

Range, 312–487 fathoms.

Bela incisula Verrill.

Trans. Conn. Acad., vol. v, p. 461, pl. 43, fig. 12; pl. 57, fig. 14, 1882.

Range, 18–480 fathoms †.

Bela Gouldii Verrill.

Trans. Conn. Acad., vol. v, p. 465, pl. 57, figs. 6, 6*a*, 1882.

Range, 300 fathoms †. (6½–122 fathoms, N. of Cape Cod.)

Bela mitrula Lovén, var. *concinnula* Verrill.

Bela concinnula Verrill, Trans. Conn. Acad., vol. v, p. 468, pl. 43, fig. 15; pl. 57, fig. 11, 1882.

Bela mitrula, var. *concinnula* Verrill, Trans. Conn. Acad., vol. vi, p. 249, 1884.

Range, 100 fathoms †; 252½–487 fathoms *.

Bela harpularia (Couth.) H. and A. Adams.

Verrill, Trans. Conn. Acad., vol. v, p. 473, pl. 43, fig. 14; pl. 57, fig. 9, 1882.

Range, 18–28½ fathoms *; 368 fathoms †.

Bela cancellata (Mighels) Stimpson.

Verrill, Trans. Conn. Acad., vol. v, p. 475, pl. 43, figs. 10, 11; pl. 57, fig. 13, 1882.

Range, 126–319 fathoms †.

Bela pleurotomaria (Couthouy) Adams.

Verrill, Trans. Conn. Acad., vol. v, p. 478, 1882.
Bush, Proc. U. S. Nat. Mus., vol. vi, p. 238, pl. 9, fig. 7, 1883.

Range, 16–208 fathoms †.

Taranis Mörchii (Malm) Jeffreys.

Verrill, Trans. Conn. Acad., vol. v, p. 486, pl. 57, fig. 18, 1882; vol. vi, p. 251, 1884.

Range, 365 fathoms †; 368 fathoms *.

Taranis pulchella Verrill.

Trans. Conn. Acad., vol. v, p. 487, pl. 57, fig. 17, 1882; vol. vi, pl. 29, fig. 8, 1884.

Range, 349–487 fathoms.

Admete Couthouyi (Jay) Ad. (=*A. viridula* Gld.).

Range, 155–487 fathoms.

RACHIGLOSSA.

Marginella borealis Verrill.

Marginella carnea Verrill, Trans. Conn. Acad., vol. v, p. 489, 1882.
Marginella borealis Verrill, Trans. Conn. Acad., vol. vi, p. 165, pl. 29, fig. 4, 1884.

Range, 64–100 fathoms †.

Buccinum undatum Linné.

Verrill, Trans. Conn. Acad., vol. v, pl. 58, fig. 10, 1882.

Range, 11–55 fathoms *; 57½–312 fathoms †.

Buccinum Sandersoni Verrill.

Trans. Conn. Acad., vol. v, p. 490, pl. 58, fig. 9, 1882.

Range, 156 fathoms †; 208–264 fathoms *.

Sipho Stimpsonii Mörch. (=*Fusus Islandicus* Gould.)

Verrill, Trans. Conn. Acad., vol. v, p. 499 (note), pl. 57, fig. 24, 1882.

Range, 16–300 fathoms.

Sipho Stimpsonii Mörch, var. *liratulus* Verrill.

Neptunea (*Sipho*) *arata* Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 370, 1880.
Sipho Stimpsonii, var. *liratulus* Verrill, Trans. Conn. Acad., vol. v, p. 500 (note), 1882.

Range, 56–115 fathoms †; 120–319 fathoms *.

Sipho pubescens Verrill.

Trans. Conn. Acad., vol. v, p. 501, pl. 43, fig. 6; pl. 57, fig. 25, 1882.

Range, 56–640 fathoms †; 192–435 fathoms *.

Sipho pygmæus Gld.

Verrill, Trans. Conn. Acad., vol. v, p. 501 (note), pl. 57, fig. 21, 1882.

Range, 12–374 fathoms*; 435 fathoms†.

Sipho pygmæus Gld., var. *planulus* Verrill.

Trans. Conn. Acad., vol. v, p. 505 (note), 1882.

Range, 20–350 fathoms.

Sipho parvus Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 504, pl. 57, figs. 20, 20*a*, 20*b*, 1882.

Range, 192–616 fathoms.

Sipho glyptus Verrill.

Trans. Conn. Acad., vol. v, p. 505, pl. 57, fig. 22; pl. 58, figs. 1, 1*a*, 1882.

Range, 193–458 fathoms.

Sipho cælatus Verrill.

Neptunea (*Sipho*) *cælata* Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 369, 1880.

Sipho cælatus Verrill, Trans. Conn. Acad., vol. v, p. 506, pl. 57, figs. 19, 19*a*, 1882.

Range, 302–487 fathoms*; 616 fathoms†.

Sipho leptaleus Verrill.

Trans. Conn. Acad., vol. vi, p. 175, pl. 31, fig. 16, 1884.

Range, 452 fathoms †.

Neptunea despecta Linné, var. *tornatus* Gld.

Range, 100 fathoms†. Northern.

Neptunea decemcostata (Say) H. & A. Ad.

Range, 6–322 fathoms†; 41–61½ fathoms*.

Nassa nigrolabra Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 371, 1880; Trans. Conn. Acad., vol. v, p. 512, pl. 58, fig. 12, 1882.

Range, 155 fathoms*; 349 fathoms†.

Trophon Lintoni Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. vi, p. 176, pl. 29, fig, 1, 1884.

Range, 70 fathoms †.

Anachis Haliæeti (Jeff.) Verrill.

Anachis Haliæeti Verrill, Amer. Journ. Sci., vol. vii, p. 405, 1874.

Anachis costulata Verrill, Trans. Conn. Acad., vol. v, p. 513, pl. 43, fig. 7, 1882.

Anachis Haliæeti Verrill, Trans. Conn. Acad., vol. vi, p. 252, 1884.

Range, 79 fathoms†; 115–640 fathoms*.

Astyris diaphana Verrill.

Trans. Conn. Acad., vol. v, p. 513, pl. 58, fig. 2, 1882.

Range, 64 fathoms†; 100–487 fathoms*.

Astyris zonalis (Lins.) Verrill.

Verrill, Report Invert. Anim. Vineyard Sd., p. 351 (auth. copy), pl. 21, fig. 111, 1874.

Range, 19–202 fathoms.

Astyris pura Verrill.

Trans. Conn. Acad., vol. v, p. 515, 1882.

Range, 71 fathoms †; 100–487 fathoms *.

TÆNIOGLOSSA.

Dolium Bairdii Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xxii, p. 299, Oct., 1881; Trans. Conn. Acad., vol. v, p. 515, 1882; vol. vi, p. 253, pl. 29, figs. 2, 2*a*, 2*b*, 1884.

Range, 89–234 fathoms; † 104–202 fathoms*.

Natica clausa Brod. & Sowerby.
Range, 13–193 fathoms †; 238–487 fathoms*.

Lunatia heros (Say) H. & A. Ad.
Range, 0–238 fathoms.

Lunatia Grœnlandica (Möll.) Ad.
Range, 12½–368 fathoms †; 301–365 fathoms*.

Lunatia nana (Möll.) Sars.

Verrill, Proc. U. S. Nat. Mus., vol. ii, p. 197, 1879; Trans. Conn. Acad., vol. v, p. 516, pl. 42, fig. 9, 1882.

Range, 27–28 fathoms*; 30 fathoms†; north of Cape Cod, 15–190 fathoms*; 430 fathoms †.

Lamellaria pellucida Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 372, 1880; Trans. Conn. Acad., vol. v, p. 518, pl. 58, figs. 4, 5, 5*a*, 1882.

Range, 86–787 fathoms.

Lamellaria pellucida, var. *Gouldii* Verrill.

Trans. Conn. Acad., vol. v, p. 518, pl. 58, fig. 3, 1882.

Range, 44–458 fathoms.

Velutina lævigata (L.) Gould.
Range, 15½–71 fathoms *; 100–130 fathoms†.

Crepidula plana Say.
Range, 3½–31 fathoms *; 155–487 fathoms†.

Crucibulum striatum (Say) Ad.
Range, 5–65 fathoms *; 110 fathoms †.

Capulus Hungaricus (Linné).

Verrill, Trans. Conn. Acad., vol. v, p. 519, 1882; vol. vi, pl. 29, fig. 6, 1884.

Range, 71–458 fathoms.

Torellia fimbriata Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 520, pl. 57, figs. 27, 27*a*, 1882.

Range, 142½–321 fathoms.

Torellia fimbriata, var. *tiarella* Verrill.

Trans. Conn. Acad., vol. v, p. 521, 1882.

Range, 182 fathoms.

Torellia vestita Jeffreys.

Verrill, Amer. Journ. Sci., vol. v, p. 15, Jan., 1873; Trans. Conn. Acad., vol. v, p. 521, pl. 42, fig. 5, 1882.

Range, 4½–86 fathoms†; 146–317 fathoms*.

Cerithiella Whiteavesii Verrill.

Lovenella Whiteavesii Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 375, 1880.
Cerithiella Whiteavesii Verrill, Trans. Conn. Acad., vol. v, p. 522, pl. 42, fig. 7, 1882.

Range, 238–487 fathoms.

Aporrhais occidentalis Beck.

Range, 34½–640 fathoms†; 115–349 fathoms*.

Fossarus elegans Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 522, pl. 57, fig. 28, 1882.

Range, 100 fathoms†.

Litiopa bombix Rang.

Verrill, Trans. Conn. Acad., vol. v, p. 523, 1882.

Surface.

Cingula harpa Verrill.

Rissoa (*Cingula*) *harpa* Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 374, 1880.
Cingula harpa Verrill, Trans. Conn. Acad., vol. v, p. 523, pl. 58, fig. 6, 1882.

Range, 319–487 fathoms†.

Cingula turgida? (Jeff.) Verrill.

Verrill, Trans. Conn. Acad., vol. v, p. 524, 1882.

Range, 487 fathoms†.

Cingula areolata (Stimp.) Verrill.

Verrill, Amer. Journ. Sci., vol. xvii, p. 311, April, 1879; Trans. Conn. Acad., vol. v, p. 524, pl. 43, fig. 2, 1882.

Range, 134–349 fathoms.

Cingula Jan-Mayeni (Friele) Verrill.

Verrill, Amer. Journ. Sci., vol. xvii, p. 311, April, 1879; Trans. Conn. Acad., vol. v, p. 524, p. 42, fig. 8, 1882.

Range, 238–487 fathoms.

Cingula brychia Verrill.

Trans. Conn. Acad., vol. vi, p. 179, pl. 32, fig. 9, 1884.

Range, 349–487 fathoms.

Cingula carinata Migh.

Range, 18–335 fathoms †.

Cingula aculeus Gld.

Range, 4–349 fathoms ?.

Cithna (?) olivacea Verrill.

Trans. Conn. Acad., vol. vi, p. 185, pl. 29, fig. 5, 1884.

Range, 193 fathoms †.

PTENOGLOSSA.

Scalaria Dalliana Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 395, Nov., 1880; Trans. Conn. Acad., vol. v, p. 527, pl. 57, fig. 33, 1882.

Range, 85 fathoms †; 115–193 fathoms *.

Scalaria Pourtalesii Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 395, Nov., 1880; Trans. Conn. Acad., vol. v, p. 527, pl. 57, fig. 32, 1882.

Range, 85–146 fathoms.

Scalaria (Cirsotrema) Leeana Verrill.

Trans. Conn. Acad., vol. v, p. 526, pl. 57, fig. 34, 1882.

Range, 146 fathoms †.

Scalaria (Opalia) Andrewsii Verrill.

Trans. Conn. Acad., vol. v, p. 526, pl. 57, fig. 35, 1882.

Range, 100 fathoms †.

Acirsa gracilis Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 377, 1880; Trans. Conn. Acad., vol. v, p. 528, pl. 57, fig. 31, 1882.

Range, 349–452 fathoms †; 487 fathoms *.

Aclis striata Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 377, 1880; Trans. Conn. Acad., vol. v, p. 528, pl. 58, fig. 13, 1882.

Range, 100 fathoms.

Aclis Walleri Jeffreys.

Verrill, Trans. Conn. Acad., vol. v, p. 528, pl. 57, fig. 36, 1882.

Range, 349 fathoms †; 365–487 fathoms *.

Aclis tenuis Verrill.

Trans. Conn. Acad., vol. v, p. 528, pl. 58, fig. 19, 1882.

Range, 100 fathoms.

Solarium boreale Verrill and Smith. MSS.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 376, 1880; Trans. Conn. Acad., vol. v, p. 529, pl. 57, figs. 29, 30, 1882.

Range, 115 fathoms *; 146–193 fathoms †.

RHIPHIDOGLOSSA.

Calliostoma Bairdii Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 396, Nov., 1880; Trans. Conn. Acad., vol v, p. 530, pl. 57, fig. 26, 1882.

Range, 56–640 fathoms †; 64–192 fathoms *.

Calliostoma occidentale (Migh.).

Range, 207 fathoms †; 365–640 fathoms*.

Margarita regalis Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 397, Nov., 1880; Trans. Conn. Acad., vol. v, p. 530, pl. 57, fig. 37, 1882; vol. vi, p. 254, pl. 29, fig. 14, 1884.

Range, 64–173 fathoms †; 193–787 fathoms *.

Margarita lamellosa Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 397, Nov., 1880; Trans. Conn. Acad., vol. v, p. 530, pl. 57, fig. 38, 1882.

Range, 100–192 fathoms †.

Machæroplax obscura (Couth.) Friele.

Range, 12½–487 fathoms.

Machæroplax obscura, var. *carinata* Verrill.

Trans. Conn. Acad., vol. v, p. 532, 1882.

Range, 100–208 fathoms †; 266–335 fathoms*.

Cyclostrema Dalli Verrill.

Trans. Conn. Acad., vol. v, p. 532, pl. 57, fig. 39, 1882; vol. vi, p. 255, pl. 29, fig. 15; pl. 32, fig. 17 (variety), 1884.

Range, 487 fathoms.

Cyclostrema affine Verrill.

Cyclostrema rugulosum Verrill, Trans. Conn. Acad., vol. v, p. 533, 1883 (*non* Sars).
Cyclostrema affine Verrill, Trans. Conn. Acad., vol. vi, p. 199, pl. 32, fig. 15, 1884.

Range, 365 fathoms†.

Scissurella crispata Flem.

Verrill, Trans. Conn. Acad., vol. v, p. 533, 1882.

Range, 238 or 365 fathoms.

Fissurella Tanneri Verrill.

Proc. U. S. Nat. Mus., vol. v, p. 333, 1882; Trans. Conn. Acad., vol. vi, p. 255, pl. 29, figs. 13, 13*a*, 1884.

Range, 104 fathoms.

Puncturella noachina (L.) Lowe.

Range, 16 fathoms †; 34–640 fathoms*.

Propilidium pertenne? Jeff.

Verrill, Trans. Conn. Acad., p. 262, 1884.

Range, 640 fathoms, in egg-case of *Raia*.

Addisonia paradoxa Dall.

Dall, Proc. U. S. Nat. Mus., vol. iv, p. 405, 1882.
Verrill, Trans. Conn. Acad., vol. v, p. 533, 1882; vol. vi, p. 256, pl. 29, figs. 10, 11, 11*a*, 11*b*, 1884.

Range, 71–640 fathoms.

Cocculina Beanii Dall.

Dall, Proc. U. S. Nat. Mus., vol. iv, p. 403, 1882.
Verrill, Trans. Conn. Acad., vol. v, p. 533, 1882; vol. vi, pl. 29, fig. 12, 1884.

Range, 365 fathoms †.

Cocculina spinigera Jeffreys.

Verrill, Trans. Conn. Acad., vol. vi, p. 203, 1884.

Range, 335 fathoms, in bored wood.

Cocculina Dalli Verrill.

Trans. Conn. Acad., vol. vi, p. 203, 1884.

Range, 317 fathoms †.

Cocculina Rathbuni Dall.

Dall, Proc. U. S. Nat. Mus., vol. iv, p. 403, 1882.
Verrill, Trans. Conn. Acad., vol. v, p. 534, 1882.

Range, 100–616 fathoms.

DOCOGLOSSA.

Lepetella tubicola Verrill and Smith. MSS.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 375, 1880.
Dall, Proc. U. S. Nat. Mus., vol. iv, p. 408, 1882.
Verrill, Trans. Conn. Acad., vol. v, p. 534, pl. 58, figs. 29, 29*a*, 1882.

Range, 134–396 fathoms.

POLYPLACOPHORA.

Trachydermon exaratus (G. O. Sars).

Verrill, Trans. Conn. Acad., vol. vi, p. 208, pl. 30, figs. 2, 2*a*, 2*b*, 1884.

Range, 194 fathoms.

Leptochiton alveolus (Sars) Lovén.

Verrill, Trans. Conn. Acad., vol. v, p. 534, 1882.

Range, 291–640 fathoms.

Hanleyia mendicaria (Migh.) Carp.

Range, 317 fathoms.

Placophora (*Euplacophora*) *Atlantica* Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. vi, p. 206, pl. 30, figs. 1, 1*a*, 1*b*, 1884.

Range, 640 fathoms.

GYMNOGLOSSA.

Stilifer Stimpsonii Verrill.

Verrill, Amer. Journ. Sci., vol. iii, p. 283, April, 1872; Trans. Conn. Acad., vol. v, p. 535, fig. 2, 1882.

Range, 6–410 fathoms.

Stilifer curtus Verrill.

Trans. Conn. Acad., vol. v, p. 535, 1882.

Range, 410 fathoms.

Eulima intermedia Cantraine.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 379, 1880; Trans. Conn. Acad., vol. v, p. 535, pl. 58, fig. 20, 1882.

Range, 85–155 fathoms.

Eulima distorta Deshayes.

Verrill, Trans. Conn. Acad., vol. v, p. 536, 1882.

Range, 115 fathoms.

Turbonilla nivea (Stimp.) Ad.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 379, 1880.

Range, 100–157 fathoms †.

Turbonilla Emertoni Verrill.

Trans. Conn. Acad., vol. v, p. 536, pl. 58, figs. 14, 14*a*, 1882.

Range, 238 fathoms.

Turbonilla Rathbuni Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 398, Nov., 1880; Trans. Conn. Acad., vol. v, p. 536, pl. 58, fig. 15, 1882.

Range, 64–452 fathoms †; 100–365 fathoms *.

Turbonilla Bushiana Verrill.

Trans. Conn. Acad., vol. v, p. 537, pl. 58, fig. 16, 1882.

Range, 365–487 fathoms.

Eulimella Smithii Verrill.

Turbonilla Smithii Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 380, 1880.
Eulimella Smithii Verrill, Trans. Conn. Acad., vol. v, p. 538, pl. 58, fig. 18, 1882.

Range, 85–120 fathoms*; 146 fathoms†.

Odostomia unidentata (Mont.)

G. O. Sars, Moll. Reg. Arct. Norvegiæ, p. 201, pl. 11, figs. 6–8, 1878.

Range, 100–115 fathoms†.

Odostomia, sp.

Verrill, Trans. Conn. Acad., vol. v, p. 539, 1882.

Range, 365 fathoms†.

Menestho sulcata Verrill.

Odostomia (Menestho) sulcata Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 380, 1880.
Menestho sulcata Verrill, Trans. Conn. Acad., vol. v, p. 539, pl. 58, fig. 17, 1882.

Range, 115–365 fathoms†.

Menestho Bruneri Verrill.

Trans. Conn. Acad., vol. v, p. 539, 1882.

Range, 487 fathoms.

TECTIBRANCHIATA.

Actæon nitidus Verrill.

Trans. Conn. Acad., vol. v, p. 540, pl. 58, fig 21, 1882.

Range, 238–487 fathoms.

Ringicula nitida Verrill.

Trans. Conn. Acad., vol. iii, p. 48, pl. 1, fig. 2, 1874; vol. v, p. 540, 1882.

Range, 100–115 fathoms†; 120–487 fathoms*.

Choristes elegans Carp., var. *tenera* Verrill.

Trans. Conn. Acad., vol. v, p. 541, pl. 58, figs. 27, 27*a*, 1882; vol. vi, p. 256, pl. 29, figs. 9, 9*a*, 9*b*, 1884.

Range, 193 fathoms†; 255–640 fathoms*.

Cylichna Dalli Verrill.

Trans. Conn. Acad., vol. v, p. 542, 1882; vol. vi, pl. 29, fig. 15, 1884.

Range, 452 fathoms†.

Cylichna alba (Brown) Lovén.
Range, 12–487 fathoms.

Cylichna occulta (Migh.) Ad.
Range, 100–480 (?) fathoms*; 487 fathoms†.

Diaphana gemma Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 382, 1880; Trans. Conn. Acad., vol. v. p. 543, pl. 58, fig. 22, 1882.

Range, 100–115 fathoms*; 322 fathoms†.

Diaphana conulus (Desh.) Verrill.

Verrill, Trans. Conn. Acad., vol. v, p. 543, pl. 58, fig. 25, 1882.

Range, 100 fathoms †; 155 fathoms *.

Diaphana nitidula (Lovén) Verrill.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 381, 1880; Trans. Conn. Acad., vol. v, p. 543, 1882.

Range, 155–487 fathoms.

Diaphana pertenuis (Mighels) Verrill.

Range, 319–386 fathoms.

Amphisphyra globosa Lovén.

Verrill, Trans. Conn. Acad., vol. v, p. 543, 1882.

Range, 115–365 fathoms †; 319 fathoms *.

Amphisphyra pellucida (Brown) Lovén.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 382, 1880.

Range, 120 fathoms †; 365 fathoms *.

Scaphander puncto-striatus (Migh.) Ad.

Range, 46–787 fathoms.

Philine quadrata (Wood) Forb. & Han.

Range, 28–266 fathoms †; 20–480 fathoms *.

Philine amabilis Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 383, 1880; Trans. Conn. Acad., vol. v, p. 544, pl. 58, figs. 23, 24, 1882.

Range, 120–156 fathoms.

Philine cingulata G. O. Sars.

Verrill, Trans. Conn. Acad., vol. v, p. 544, 1882.

Range, 155–487 fathoms.

Philine Finmarchica M. Sars.

Verrill, Trans. Conn. Acad., vol. v, p. 544, 1882.

Range, 86 fathoms.

Philine tincta Verrill.

Trans. Conn. Acad., vol. v, p, 544, 1882.

Range, 67 fathoms.

Koonsia obesa Verrill.

Trans. Conn. Acad., vol. v, p. 545, 1882; vol. vi, pl. 28, fig. 7, 1884.

Range, 192–312 fathoms.

Pleurobranchia tarda Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 384, 1880; Trans. Conn. Acad., vol. v, p. 546, pl. 58, fig. 26, 1882.

Range, 28–640 fathoms.

NUDIBRANCHIATA.

Heterodoris robusta Verrill and Emerton. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 549, pl. 58, figs. 35, 35*a*, 35*b*, 1882; vol. vi, pl. 28, figs. 5, 5*a*, 1884.

Range, 458 fathoms.

Issa ramosa Verrill and Emerton. MSS.

Verrill, Amer. Journ. Sci., vol. xxii, p. 301, Oct., 1881; Trans. Conn. Acad., vol. v, p. 547, pl. 58, figs. 36, 36*a*, 1882.

Range, 100–321 fathoms.

Doris complanata Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 386, 1880; Trans. Conn. Acad., vol. v, p. 549. pl. 58, figs. 34, 34*a*, 34*b*, 1882; vol. vi, pl. 28, fig. 6, 1884.

Range, 86–194 fathoms.

Dendronotus robustus Verrill.

Amer. Journ. Sci., vol. l, p. 405, fig. 1, Nov., 1870; Trans. Conn. Acad., vol. v, p. 550, 1882.

Range, 28–317 fathoms.

Dendronotus arborescens Ald. & Han.

Range, 13–351 fathoms.

Doto coronata (Gm.) Ald. & Han.

Surface.

Fiona nobilis Ald. & Han.

Verrill, Trans. Conn. Acad., vol. v, p. 551, 1882.

Surface, on timber.

Coryphella, sp.

Range, 30–168 fathoms.

Facelina pilata (Gld.) Verrill.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 389, 1880.

Range, low water to 146 fathoms.

Eolis papillosa (Linné) Forb. & Han.

Range, 13–208 fathoms.

Tergipes despectus (Johnst.) Ald. & Han.

Verrill, Report Invert. Anim. Vineyard Sd., p. 373 (auth. copy), 1874; Proc. U. S. Nat. Mus., vol. iii, p. 391, 1880.

Range, shore to 8 fathoms; also at surface.

HETEROPODA.

Carinaria Atlantica Ad. & R.

Verrill, Trans. Conn. Acad., vol. v, p. 529, 1882.

Not taken living, 65 fathoms†.

Atlanta Peronii Lesueur.

Verrill, Trans. Conn. Acad., vol. v, p. 529, 1882; vol. vi, pl. 28, figs. 4, 4*a*, 1884.

Not obtained living, 317 fathoms†.

PTEROPODA.

Cymbulia calceolus Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 391, 1880; Trans. Conn. Acad., vol. v, p. 553, pl. 58, fig. 33, 1882.

Range, 18–487 fathoms†; surface*.

Cavolina tridentata (Forskal) H. & A. Ad.

Verrill, Trans. Conn. Acad., vol. v, p. 554, figs. 6, 7, 1882.

Range, 45–487 fathoms†; surface*.

Cavolina uncinata (D'Orb.) Gray.

Verrill, Trans. Conn. Acad., vol. v, p. 554, 1882.

Range, 64–487 fathoms†; surface*.

Cavolina longirostris (Les.)

Verrill, Trans. Conn. Acad., vol. v, p. 555, 1882.

Range, 64–487 fathoms†; surface*.

Cavolina gibbosa (Rang).

Verrill, Trans. Conn. Acad., vol. vi, p. 213, 1884.

Range, 193 fathoms†.

Cavolina inflexa (Les.) Gray.

Verrill, Trans. Conn. Acad., vol. v, p. 555, 1882.

Range, 487 fathoms†.

Diacria trispinosa Gray.

Range, 64–487 fathoms†.

Clio pyramidata Linné.

Verrill, Trans. Conn. Acad., vol. v, p. 555, 1882.

Range, 64–487 fathoms†.

Balantium recurvum Children.

Verrill, Trans. Conn. Acad., vol. v, p. 556, 1882.

Range, 64–238 fathoms†.

Triptera columnella (Rang).

Verrill, Trans. Conn. Acad., vol. v, p. 557, 1882; vol. vi, p. 214, 1884.

Range, 319–321 fathoms†.

Spiriales Gouldii St. (*? S. balea* Möll., var.).

Surface.

Spirialis retroversus Flem., var. *MacAndrei* Forbes & Han.

Spirialis MacAndrei Verrill, Trans. Conn. Acad., vol. v, p. 557, 1882.

Range, 319–386 fathoms †; surface *.

Clione papilionacea Pallas.

Verrill, Report Invert. Anim. Vineyard Sd., p. 374 (auth. copy), 1874.

Range, surface to 389 fathoms(?).

SOLENOCHONCHA OR SCAPHOPODA.

Dentalium striolatum Stimp.

Range, 20–115 fathoms †; 146–487 fathoms *.

Dentalium occidentale Stimp.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 394, 1880; Trans. Conn. Acad., vol. v, pl. 42, figs. 16*a*, *b*, 17, 18, 1882.

Range, 26–115 fathoms †; 146–487 fathoms *.

Cadulus Pandionis Verrill and Smith, MSS.

Verrill, Amer. Journ. Sci., vol. xx, p. 399, Nov., 1880; Trans. Conn. Acad., vol. v, p. 558, pl. 58, figs. 30, 30*a*, 1882.

Range, 85–487 fathoms.

Cadulus propinquus ? G. O. Sars.

Verrill, Trans. Conn. Acad., vol. v, p. 558, pl. 58, figs. 31, 32, 1882; vi, p. 257, 1884.

Range, 100–115 fathoms.

Cadulus Jeffreysii ? Monterosato.

Verrill, Trans. Conn. Acad., vol. v, p. 559, 1882; vi, p. 257, 1884.

Range, 115 fathoms.

Siphonodentalium vitreum M. Sars.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 394, 1880; Trans. Conn. Acad., vol. v, p. 557, pl. 42, fig. 19, 1882.

Range, 100 fathoms †; 349–487 fathoms *.

Siphonentalis affinis (Sars).

Verrill, Trans. Conn. Acad., vol. v, p. 558, pl. 42, figs. 20*a*, *b*, 1882.

Range, 349–365 fathoms †.

Siphonentalis Lofotensis (M. Sars).

Verrill, Trans. Conn. Acad., vol. v, p. 558, 1882.

Range, 115 fathoms *; 365–480 fathoms †.

LAMELLIBRANCHIATA.

Teredo megotara Hanley.

Range, 55 fathoms †; 100–358 fathoms *, in wood; surface *.

Xylophaga dorsalis (Turton) Forbes & Hanley.

Verrill, Trans. Conn. Acad., vol. v, p. 559, pl. 44, fig. 9, 1882.

Range, 32–374 fathoms.

Ensatella Americana (Gld.) Verrill.

Verrill, Report Invert. Anim. Vineyard Sd., p. 380 (auth. copy), pl. 26, fig. 182; pl. 32, fig. 245, 1874.

Range, 0–28½ fathoms *; 64–89 fathoms †.

Mya truncata Linné.

Range, 34–110 fathoms †.

Saxicava Norvegica (Speng.) Woodw.

Range, 20–506 fathoms †; 300 fathoms*.

Cyrtodaria siliqua (Speng.) Woodw.

Range, 28–258 fathoms †.

Poromya granulata (Nyst) F. & Han.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 396, 1880; Trans. Conn. Acad., vol. v, p. 564, pl. 44, figs. 3, 4, 1882.

Range, 64–146 fathoms †; 93–120 fathoms*.

Poromya granulata, var. *rotundata* (G.) Verrill.

Poromya rotundata Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 396, 1880.
Poromya granulata, var. *rotundata* Verrill, Trans. Conn. Acad., vol. v, p. 565, 1882.

Range, 64–115 fathoms.

Neæra obesa Lovén.

Verrill, Trans. Conn. Acad., vol. v, p. 563, pl. 44, fig. 10*c*, 1882.

Range, 192–487 fathoms; 20 to 150 fathoms, north of Cape Cod.

Neæra glacialis G. O. Sars.

Verrill, Trans. Conn. Acad., vol. v, p. 562, pl. 44, figs. 10*a*, *b*, 1882.

Range, 64–487 fathoms.

Neæra rostrata (Speng.) Lovén.

Verrill, Trans. Conn. Acad., vol. v, p. 562, pl. 58, fig. 39, 1882.

Range, 67–487 fathoms †; 85–155 fathoms*.

Neæra lamellosa M. Sars.

Verrill, Trans. Conn. Acad., vol. v, p. 561, 1882; vol. vi, pl. 30, fig. 3, 1884.

Range, 319–487 fathoms.

Neæra multicostata Verrill and Smith. MSS.

Verrill, Trans. Conn. Acad., vol. v, p. 559, pl. 58, fig. 40, 1882.

Range, 85–158 fathoms.

Neæra multicostata, var. *curta* Jeffreys.

Verrill, Trans. Conn. Acad., vol. v, p. 560, 1882.

Range, 115–120 fathoms †.

Neæra perrostrata Dall.

Verrill, Trans. Conn. Acad., vol. v, p. 561, 1882.

Range, 85–325 fathoms.

Pecchiolia abyssicola G. O. Sars.

Verrill, Trans. Conn. Acad., vol. v, p. 565, 1882.

Range, 192–487 fathoms.

Pecchiolia gemma Verrill.

Trans. Conn. Acad., vol. v, p. 565, 1882; vol. vi, p. 258, pl. 30, figs. 7, 8, 1884.

Range, 349–487 fathoms.

Verticordia cœlata Verrill.

Trans. Conn. Acad., vol. v, p. 566, 1882; vol. vi, pl. 30, figs. 9, 9*a*, 1884.

Range, 100 fathoms †.

Mytilimeria flexuosa Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xxii, p. 302, 1881; Trans. Conn. Acad., vol. v, p. 567, pl. 58, fig. 38, 1882; vol. vi, p. 258, 1884.

Range, 319 fathoms †; 349 fathoms*.

Kennerlia glacialis (Leach) Carp.

Verrill, Trans. Conn. Acad., vol. v, p. 567, 1882.

Bush, Proc. U. S. Nat. Mus., vol. vi, p. 245, pl. 9, figs. 1, 1*a*, 1883.

Range, 63–100 fathoms.

Clidiophora trilineata (Say) Carp.

Range 0–29 fathoms*; 45–126 fathoms †.

Periploma papyracea (Say) Verrill.

Verrill, Amer. Journ. Sci., vol. iii, p. 285, pl. 7, figs. 1, 1*a*, 1*b*; pl. 8, fig. 1, April, 1872.

Range, 7–321 fathoms.

Thracia Conradi Couth.

Range, 4½–193 fathoms †; 34 fathoms*.

Pholadomya arata Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xxii, p. 301, Oct., 1881; Trans. Conn. Acad., vol. v, p. 567, pl. 58, fig. 37, 1882; vol. vi, pl. 30, figs. 4, 5, 6, 1884.

Range, 71–134 fathoms †.

Spisula solidissima (Dillw.) Gray.

Range, 0–192 fathoms †; 0–18 fathoms*.

Spisula ovalis Gld.

Range, 5–71 fathoms †; 8½–15 fathoms *.

Ceronia arctata (Con.) Ad.

Range, 0–183 fathoms †; 0–2 fathoms *.

Macoma sabulosa (Speng.) Mörch.

Verrill, Report Invert. Anim. Vineyard Sd., p. 383 (auth. copy), 1874.

Range, 30–410 fathoms †; 29–266 fathoms *.

Abra lioica (Dall) V.

Syndosmya lioica Dall, Bull. Mus. Comp. Zool., vol. ix, p. 133, 1881.
Verrill, Trans. Conn. Acad., vol. v, p. 568, 1882; vol. vi, p. 224.

Range, 100 fathoms *; 115 fathoms †.

Callista convexa (Say) Ad.

Range, 0–21 fathoms *; 85 fathoms †.

Cyprina Islandica (Linné) Lam.

Range, 8–128 fathoms *; 130–349 fathoms †.

Cardium pinnulatum Conrad.

Range, 1–266 fathoms.

Cardium (Fulvia) peramabilis Dall.

Dall, Bull. Mus. Comp. Zool., vol. ix, p. 132, 1881.
Verrill, Trans. Conn. Acad., vol. v, p. 569, 1882.

Range, 115 fathoms †.

Diplodonta turgida Verrill and Smith. MSS.

Verrill, Amer. Journ. Sci., vol. xxii, p. 303, Oct., 1880; Trans. Conn. Acad., vol. v, p. 569, pl. 58, fig. 42, 1882; vol. vi, pl. 30, figs. 10, 11, 1884.

Range, 71–89 fathoms †.

Loripes lens Verrill and Smith. MSS.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 400, 1880; Trans. Conn. Acad., vol. v, p. 569, 1882; vol. vi, p. 259, 1884.

Range, 5–192 fathoms †; 120 fathoms *.

Lucina filosa Stimp.

Range, 4–349 fathoms †.

Cryptodon obesus Verrill.

Amer. Journ. Sci., vol. iii, p. 287, pl. 7, fig. 2, April, 1872; Trans. Conn. Acad., vol. v, p. 569, 1882.

Range, 10–365 fathoms †; 115–349 fathoms *.

Cryptodon Gouldii (Phil.) Stimp.

Range, 6–335 fathoms.

Cryptodon subovatus (Jeff.) Verrill.

Verrill, Trans. Conn. Acad., vol. v, p. 570, 1882.

Range, 480 fathoms †.

Cryptodon ferruginosus (Forbes).

Verrill, Trans. Conn. Acad., vol. v, p. 570, 1882.

Range, 100–487 fathoms.

Montacuta ovata Jeffreys.

Verrill, Trans. Conn. Acad., vol. v, p. 571, 1882.

Range, 8½–157 fathoms.

Solemya velum Say.

Range, 0–115 fathoms †; 0–10 fathoms *.

Solemya velum, var. *borealis* (Totten).

Range, 28–349 fathoms †; 56–300 fathoms *.

Venericardia granulata (Say) = *V. borealis* (Conrad).

Verrill, Trans. Conn. Acad., vol. vi, p. 258, 1884.

Range, 8–435 fathoms †; 9–192 fathoms *.

Astarte castanea Say.

Range, 0–100 fathoms *; 435 fathoms †.

Astarte quadrans Gld.

Range, 11–100 fathoms.

Astarte undata Gld.

Verrill, Report Invert. Anim. Vineyard Sd., p. 390 (auth. copy), pl. 29, fig. 203, 1874.

Range, 8–480 fathoms.

Astarte crenata Gray.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 399, 1880.

Range, 34½–640 fathoms.

Nucula proxima Say.

Range, 3½–302 fathoms *; 310–365 fathoms †.

Nucula delphinodonta Mighels.

Range, 9–487 fathoms.

Nucula granulosa Verrill.

Verrill, Trans. Conn. Acad., vol. vi, p. 280, 1884.

Range, 487 fathoms.

Nucula tenuis (Mont.) Turton.

Range, 75–487 fathoms †; 302–349 fathoms *.

Yoldia limatula (Say) Woodw.

Range, 3½–252 fathoms.

Yoldia sapotilla (Gld.) Stimp.

Range, 4½ fathoms†; 12½–321 fathoms*.

Yoldia expansa Jeff.

Range, 365 fathoms.

Yoldia lucida Lovén.

Yoldia obesa Gould, Invert. Mass., ed. ii, p. 155, 1870.

Yoldia lucida Verrill, Trans. Conn. Acad., vol. v, pl. 44, fig. 1, 1882.

Range, 29–100 fathoms†; 115–480 fathoms*.

Yoldia regularis Verrill.

Trans. Conn. Acad., vol. vi, p. 228, 1884.

Range, 349 fathoms†.

Yoldia Jeffreysii (Hidalgo).

Verrill, Trans. Conn. Acad., vol. vi, p. 229, 1884.

Range, 349 fathoms.

Yoldia frigida Torell.

Verrill, Trans. Conn. Acad., vol. v, p. 573, pl. 44, fig. 2, 1882.

Range, 157–374 fathoms.

Yoldia thraciformis (Storer) Stimp.

Range, 29–182 fathoms†; 192–435 fathoms*.

Leda acuta (Conrad).

Leda unca Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 401, Jan., 1881; Trans. Conn. Acad., vol. v, p. 572, pl. 58, fig. 41, 1882.

Leda acuta Verrill, op. cit., vol. vi, p. 259, pl. 30, fig. 15, 1884.

Range, 64–225 fathoms†; 65–115 fathoms*.

Leda pernula (Müller).

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 401, Jan., 1881; Trans. Conn. Acad., vol. v, p. 572, 1882; vol. vi, pl. 30, figs. 14, 14*a*, 1884.

Range, 216 fathoms†; 300–349 fathoms*.

Leda tenuisulcata (Couth.) Stimp.

Range, 25–120 fathoms†.

Arca pectunculoides Scacchi.

Verrill, Trans. Conn. Acad., vol. v, p. 573, pl. 44, fig. 6, 1882.

Range, 79–640 fathoms.

Arca pectunculoides, var. *septentrionalis* (Sars) Jeff.

Verrill, Trans. Conn. Acad., vol. v, p. 573, 1882.

Range, 79–640 fathoms.

Arca pectunculoides, var. *Frielei* (Jeff.) Verrill.

Verrill, Trans. Conn. Acad., vol. v, p. 574, 1882.

Range, 156–487 fathoms.

Arca pectunculoides, var. *crenulata* Verrill.

Trans. Conn. Acad., vol. v, p. 575, 1882.

Range, 85–120 fathoms.

Limopsis minuta (Phil.)

Verrill, Trans. Conn. Acad., vol. v, p. 576, 1882.

Range, 64–100 fathoms†; 120–724 fathoms*.

Modiola modiolus (Linné) Turton.

Range, 0–115 fathoms*; 202 fathoms†.

Modiolaria nigra (Gray) Lovén.

Range, 1–27½ fathoms*; 31–65 fathoms†.

Modiolaria discors (Linné) Lovén.

Range, 15–90 fathoms.

Modiolaria corrugata (Stimp.) Mörch.

Range, 18–45 fathoms.

Modiolaria polita Verrill and Smith. MSS.

Modiola polita Verrill, Amer. Journ. Sci., vol. xx, p. 400, Nov., 1880.
Dall, Bull. Mus. Comp. Zool., vol. ix, p. 116, 1881.
Verrill, Trans. Conn. Acad., vol. v, p. 578, 1882; vol. vi, pl. 30, fig. 12, 1884.

Range, 238–321 fathoms.

Crenella glandula (Totten) Ad.

Range, 0–11 fathoms†; 5–100 fathoms*.

Crenella decussata (Mont.) Macg.

Verrill, Trans. Conn. Acad., vol. v, p. 578, pl. 44, fig. 7, 1882.

Range, 5 fathoms†; 11–115 fathoms*.

Dacrydium vitreum (Möller) Torell.

Verrill, Trans. Conn. Acad., vol. v, p. 579, pl. 44, figs. 8, 8*a*, 1882.

Range, 300 fathoms†; 312–487 fathoms*.

Idas argenteus Jeffreys.

Idas argenteus J., var. *lamellosus* Verrill, Trans. Conn. Acad., vol. v, p. 579, 1882; vol. vi, pl. 30, figs. 16, 16*a*, 1884.

Range, surface (on wood).

Limœa subovata (Jeff.) Monteros.

Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 402, Jan., 1881; Trans. Conn. Acad., vol. v, p. 580, 1882.

Range, 100 fathoms†; 252½–487 fathoms*.

Pecten Clintonius Say = *P. tenuicostatus* Mighels; Gould.

Verrill, Trans. Conn. Acad., vol. vi. p. 261, 1884.

Range, 8–349 fathoms †; 13–146 fathoms *.

Pecten Islandicus Müller.

Range, 33–90 fathoms *; 100–194 fathoms †.

Pecten glyptus Verrill.

Trans. Conn. Acad., vol. v, p. 580, 1882.

Range, 85–156 fathoms †.

Pecten vitreus (Gmel.) Wood.

Verrill, Amer. Journ. Sci., vol. xvi, p. 378, 1878; Trans. Conn. Acad., vol. 4, p. 580, pl. 42, fig. 21, 1882.

Range, 57½–64 fathoms †; 100–787 fathoms *.

Pecten pustulosus Verrill.

Amer. Journ. Sci., vol. v, p. 14, Jan., 1873; Trans. Conn. Acad., vi, p. 261, 1884.
Pecten Hoskynsi Forbes, var. *pustulosus* Verrill, Trans, Conn. Acad., vol. v, p. 581, pl. 42, figs. 22, 22*a*, 1882.

Range, 120–321 fathoms *; 365 fathoms †.

Pecten striatus Müller.

Verrill, Trans. Conn. Acad., vol. vi, p. 233, 1884.

Range, 100 fathoms †.

Amussium, sp. nov.

Pecten fenestratus Verrill, Proc. U. S. Nat. Mus., vol. iii, p. 403, Jan., 1881 (*non* Forbes).
Amussium fenestratum Verrill, Trans. Conn. Acad., vol. v, p. 582, 1882.
Amussium, sp., Verrill, Trans. Conn. Acad., vol. vi, p. 261, 1884.

Range, 79 fathoms †; 86–317 fathoms *.

Avicula hirundo (Linné).

Verrill, Trans. Conn. Acad., vol. v, p. 582, 1882.

Range, 71 fathoms *; 89 fathoms †.

Avicula hirundo, var. *nitida* Verrill.

Proc. U. S. Nat. Mus., vol. iii, p. 402, Jan., 1881; Trans. Conn. Acad., vol. v, p. 582, pl. 58, fig. 43, 1882.

Range, 64–192 fathoms.

Anomia aculeata Müller.

Range, shore—640 fathoms.

BRACHIOPODA.

Terebratulina septentrionalis (Couth.) Gray.

Range, 16–396 fathoms.

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XVIII.—SPECIAL RESULTS OF THE INVESTIGATIONS RELATING TO THE HERRING AND HERRING FISHERIES ON THE WEST COAST OF SWEDEN MADE DURING THE YEARS 1873-1883.*

By A. V. LJUNGMAN.

1. NATURAL HISTORY OF THE HERRING.

As regards the preparation of a natural history of the herring, I have found it necessary, in view of the principal aim of my investigations, and my limited time and means, to confine my work to the preparation of what was of special importance for this aim, and what could be obtained in the unfavorable circumstances under which I had to work. Here, as the Royal Academy of Sciences stated in its memorial of March 12, 1873, a larger force of men and an ample supply of apparatus was needed; and as this requirement was not met, I felt compelled to abandon the special investigations of such matters as formed the subjects of exclusive observations by other naturalists, and to concentrate my activity upon those subjects which were essential towards answering the questions in law and general administration, which I had met with; such as, the "spawning of the different races of herring;" the cause of the periodicity of the Bohuslän herring fisheries; and the gathering of general data relative to the races of the herring and the sprat, their propagation, growth, mode of life, their migrations, and their physical and biological causes.

As regards the different races of herring and their spawning, the investigations have shown that the herring which forms the object of the famous Bohuslän herring fisheries is a sea herring, belonging to the North Sea, which spawns partly during the first part of autumn and partly towards the end of winter or in the beginning of spring, and which only at secular periods visits the eastern part of the Skagerack; whilst the herring which permanently lives in these waters is a coast herring and spawns in spring. The younger among these coast herring seem to spawn later in spring than the older ones; according to G. Winther's observations this is also the case with the herring in the sound, which spawn in autumn. Professor Nilsson, however, supposes that the very reverse is the case with the herring in the Kattegat, which spawn in

* From "*Kortfattad berättelse öfver de under årtiondes* 1873–1883 *utförda vetenskapliga undersökningarna.*" Translated from the Swedish, by HERMAN JACOBSON.

autumn, and thinks that the younger herring spawn before the older ones. This whole question deserves to be further investigated both as regards the herring fisheries in the Kattegat, and in the North Sea. The information relative to the permanent occurrence in the eastern part of the Skagerack of herring which in autumn spawn on the coast of Bohuslän has not been fully verified. The two principal kinds of herring referred to above; viz, the coast herring, which spawns in spring, and the sea-herring, which spawns in autumn, are even at the present time caught in considerable quantities on the coast of Bohuslän. As they are principally half-grown fish of medium size, they must come mostly from some other place than the eastern Skagerack. Although it has so far been impossible to obtain absolute certainty as to the proper home of these herring, it is nevertheless highly probable that such herring from the Kattegat, or perhaps from the North Sea, pay occasional visits to the coast of Bohuslän. In that case we would perhaps be justified in speaking of an identity of race between this half-grown herring and the so-called "old" sea herring. The question of difference of race and local origin of the herring visiting the coast of Bohuslän is, however, so complicated and difficult, that it will hardly ever be satisfactorily answered; even in the best view the time for such a solution is very far distant. The external differences of shape between the different races are very small, and, moreover, individuals of one and the same race frequently differ from each other. People have gone too far, however, when on account of such differences and connecting links between the various races of herring, they have concluded that there is no difference of race at all, but only a difference of individuals. By arguing in this way, the existence of any race of animals might be denied, which would mean nothing more nor less than cutting the knot instead of solving it. If no such variations or connecting links could be proved, we would be confronted by different species, and not by varieties of one and the same species. To prove the existence of varieties presupposes always that we should find some variations from the same, which in reality are nothing but exceptions from the common rule.

Relative to the spawning season of the sea herring which, during the winter of 1877–'78, returned to the coast of Bohuslän, there has been a difference of opinion between me and Mr. von Yhlen and Prof. T. A. Smitt, who declared that these herring visited the coast of Bohuslän for the purpose of spawning, and that they spawned there during the first part of winter; whilst I maintained that they did not visit the coast for the sake of spawning, and, moreover, that they were partly herring belonging to a variety which spawns in autumn, and partly such as spawned towards the end of winter and beginning of spring; the same occurs on the east coast of Scotland, where two different kinds of herring are found, which spawn at different times. The correctness of my view has been proved by the experience of later years, and by other naturalists. Professor Smitt, in his report to the minister, of

October 25, 1880, gave the spawning season of the sea herring in accordance with my view, but Mr. von Yhlen not only held to his erroneous and fully refuted opinion, but even gave more opinions of a similar character, showing that even in his published reports he does not blush to deliberately make statements which he knows not to be true. As regards the common opinion—also defended by my opponents—that the principal characteristic of the great Bohuslän coast herring fisheries was that they related to spawning fish, I stated emphatically that this had not been the case during the greater portion of the preceding herring period, and that probably there would be no difference in this respect during the period recently begun. I also advanced a theory that, as a general rule, fisheries for spawning fish occurred about the middle of a Bohuslän herring period—changing my views in accordance with actual facts—whilst my opponents endeavored to change these facts and to make them agree with their preconceived opinion. The undoubtedly correct statement made by me in the beginning of 1879 that the herring fisheries which commenced on the northern part of the Bohuslän coast during the winter 1877–'78 were not fisheries for spawning herring, has, strange to say, been interpreted by Professor Smitt (who in 1880 took my opinion to be correct) in such a manner that I seem to have denied that a new fishing period had commenced during that winter.

As regards the herring which spawn towards the end of winter and generally in the beginning of spring, and which in comparatively small quantities are caught among the other herring, several opinions have been advanced. Some believe that these are the older and stronger individuals of the coast race of herring (spawning in spring)—Prof. S. Nilsson and others—whilst others think that they are a separate and more pelagian form of herring *(H. tridegren)*, belonging to the fauna of the eastern Skagerack. Others again suppose that, like the sea herring spawning in autumn, they are herring which, during the fishing period, have immigrated from the North Sea, in which lat er case they may either form a separate race of herring (my own view) or be simply the older among the sea herring (*F. Trybom*) which spawn in autumn. The opinion advanced by Professor Nilsson at one time (in the beginning of 1879) seems to me to offer a simple explanation of the case, and therefore is admissible; I consequently endeavored to make it agree with the circumstances of the Bohuslän herring fisheries, both between and during the herring periods. On the coast of Bohuslän, and on some other coasts, rich herring fisheries generally commence with small and inferior herring, which seem to have their home near the coast; and only after the fisheries have been continued for some time are herring caught, which come from a greater distance. This fact may be explained either by the herring living near the coast having to give way to the great masses of herring coming from the sea, or by supposing that both these kinds of herring are enticed or driven towards the coast by one and the same cause, in which case those nearer to the coast are, of

coast far enough to take from their fisheries the character of coast fisheries. Owing to the distance, it is almost impossible, at least with sail-boats, to carry on any coast fisheries on the coast of Bohuslän during the period when the sea herring do not enter but pass by the Skagerack on their way to the spawning grounds in the North Sea, as is the case during the intervals between the Bohuslän fishing periods. I have also succeeded in explaining in two new ways the secular periodicity of the Bohuslän herring fisheries; and so far all attempts to disprove my arguments have proved unsuccessful. In the first place I have endeavored to explain this periodicity by changes in the prevailing biological conditions, consisting in a gradual change of the local fauna and flora of the sea through the great masses of herring visiting these regions for many years in succession; and in the second place, by assuming a secular periodicity in all the outward conditions of nature prevailing throughout the entire region inhabited by herring. This last-mentioned periodicity is supposed to compel the great schools of herring to move from one place to the other in search of food, and also of spawning places. It is very probable, however, in my opinion, that these two causes work together. In giving this explanation I have also been able to explain the regular changes of time and place where the sea herring, during the fishing period, approach the coast of Bohuslän. By continuing my observations I arrived at the conclusion that the second way of explaining the periodicity is probably the one which reveals its most important cause, since I succeeded in showing that the Bohuslän herring periods agreed with corresponding and well-known periods in the change of weather, the occurrence of northern lights, the number of solar spots, &c.; and that the richest fisheries during a period correspond with a peculiar disturbance of or change in the relation between the solar spots and the temperature, which only takes place during the periods when there are herring fisheries on the coast of Bohuslän, but not during the intervals between the periods. These periods on an average last fifty-six years; and as several scientists, with good reason, have sought to explain these periods in the occurrence of solar spots from the varying position of the principal planets towards the sun, it seems to me that we may look in the future for so complete an explanation of all these circumstances that we shall be enabled to tell beforehand with some degree of certainty when these periods will occur, and in what respects they will differ from each other. From what is so far known relative to the Bohuslän fishing periods, I have considered myself justified in drawing the conclusion that as regards the extent of the fisheries, very extensive and less extensive periods alternate. The reason why the intervals between the fishing periods are not equally long must be sought in the fact that the herring come near the coast at a time which varies with every period, which of course also causes the fishing period on the inner coast to vary in length. It may also be supposed that the different fishing periods differ in another important point. Thus, the

present period does not seem to show a regular tendency to rapidly develop into decided autumnal fisheries, most productive on the southern part of the coast, which so strongly characterized the preceding period, so far as known the longest of all Bohuslän herring periods; the present period also began some years after the beginning of the fifty-six years' period, whilst the preceding period commenced some years before that time. My explanation of the cause of the secular periodicity of the great Bohuslän fisheries is also of great practical importance to the fisheries, as it enables us to tell with a considerable degree of certainty when the fishing period will come to a close. It is not known that any of the preceding fishing periods continued after the corresponding period of solar spots and northern lights.

In accordance with my view of the causes of the secular periodicity of the great Bohuslän herring fisheries, I was enabled to predict as early as 1875 and 1876 that a new herring period was near at hand, which prediction I based partly on the historical experience relative to the return of these herring fisheries after a certain time, and partly on the considerable changes in the great North Sea herring fisheries, observed since the winter of 1860–1870, and the occurrence of sea-herring in the western part of the Skagerack during the autumn of 1875. Since the beginning of the present fishing period, Professor Smitt stated in his report to the minister, dated April, 1878, that as early as 1876 he had mentioned in the Royal Academy of Sciences a change in the migrations of the schools of herring, caused by the circumstance that several large fish of the mackerel kind, especially those known as "herring-hunters," had come near the coast of Bohuslän; and later he refers to this statement in such manner as if he intended to say that he had predicted the near approach of a new herring period. This highly improbable supposition was proved by me to be incorrect, and nothing more has been heard regarding such "herring-hunters" from more southerly seas, where no herring are found. Nothing of the kind is known relative to the Norwegian, Scotch, Iceland, and American herring fisheries, and the first fish of the kind (herring-hunters) was caught on the coast of Bohuslän, as early as 1863, therefore many years before the changes in the North Sea herring fisheries referred to above took place. As fish belonging to southern seas are every now and then observed on the west coast of Sweden, the occurrence of these mackerel does not justify us in assuming a change in the currents of the sea; there are, moreover, circumstances which speak more for an increased access of northern than of southern water to the waters of the Skagerack.

2. History and statistics of the herring fisheries.

As regards the history and statistics of the Bohuslän herring fisheries, the result of my investigations has, so far, principally consisted in the publication of brief reviews on the history of these fisheries. But I have made extensive studies for a comparative history not only of

these, but also of the great North Sea herring fisheries, with the view to throw more light on many a fact in natural history and political economy, which is of importance in the definite solution of the great herring problem. These studies should, however, be continued in foreign libraries and archives, before it is possible to obtain sufficient material for producing a work which will materially benefit science and the public. I shall, however, give a brief review of the more important points in my observations, so far as they have been published.

As I have already stated above, I have succeeded in showing the probability that the Bohuslän herring periods form an entirely regular series, which can be traced, though not in all cases with absolute certainty, for nine centuries. Formerly all this was a matter of mere supposition, but I succeeded in furnishing undoubted proof of the herring period during the fifteenth century by the old document of June 22, 1496, relative to the Vinga coast and its allegiance to Sweden and Nestergötland. The proof which Asel Boeck produces for herring fisheries on the coast of Bohuslän during the fifteenth century is a bull of Pope Nicholas V, dated July 15, 1453, relative to the nobility's refusing to pay the tithes of fish; but this bull may refer to the Norwegian coast as well as to the Swedish coast. Still less importance can be attached to Boeck's supposition, that a legend mentioned by Peder Claussön Friis of herring fisheries which had been disturbed by sorcery refers, to the herring period of the fifteenth century.

I have also shown that the herring period mentioned by Boeck, as having taken place between 1260 and 1340, and given by him as a proof that the Bohuslän herring fisheries and the Norwegian spring herring fisheries took place about the same time, did not take place at that time. It is hardly credible that fisheries which commenced in 1260 should within a few years have developed to such a degree as to cause the islands on the coast of Bohuslän to be cultivated. King Hakon the Old died during an expedition to Scotland in 1263, and the improvements on the coast of Bohuslän for which he is praised in the Sagas, and which seem to point to rich herring fisheries, could hardly have been made during the last years of the old king's life, which were greatly disturbed by wars. There is, therefore, no reason to suppose that there were rich herring fisheries on the coast of Bohuslän during the thirteeenth century, but it is certain that such fisheries took place on the Bohuslän coast in the beginning of the fourteenth century, at the same time when it appears that but few herring came to the coast of Norway. The fisheries during the reign of King Hakon the Old, referred to by Boeck, probably took place during the first half of the thirteenth century, so that we would get two herring periods instead of one. For the same reasons that Friis, Holmberg, Boeck and others have supposed that herring fisheries took place during the reign of Hakon the Old, we may suppose that such fisheries took place during the reign of Sigurd Jorsalafar. Taking the herring periods, which are well established,

during the eleventh, sixteenth, seventeenth, and eighteenth centuries, we get a regular series of herring periods, alternating with intervals when no herring came near the coast; and we are justified in explaining this secular periodicity from natural causes.

I have gathered many important data relative to the herring periods during the seventeenth and eighteenth centuries, thus, *e. g.*, that during the seventeenth century the fisheries first came to a close in the southern part of the coast, and that during the eighteenth century the fisheries commenced in the northern part of the coast, &c.

I have studied all the old authors on the subject, and have arrived at the conclusion that as early as the first half of the seventeenth century people knew that these fisheries were secular and periodical. I think I have also succeeded in showing, in opposition to Boeck's views, that the Bohuslän herring fisheries alternate with the spring herring fisheries on the west coast of Norway, so that these two fisheries never flourished at one and the same time, but that they commenced on one coast when they came to a close on the other, and *vice versa;* and I have finally been able, guided by historic data, to predict the near approach of rich herring fisheries at a time when Mr. von Yhlen proclaimed in the newspapers that no such fisheries could be possibly looked for. I have also by my study of the comparative history of the herring fisheries been enabled to furnish important contributions towards a more correct view of the actual importance of the old Scania and Dutch herring fisheries, and have pointed towards a possible secular periodicity in the Dutch herring fisheries in the Zuider Zee and the Scotch herring fisheries in the Firth of Forth and the Moray Firth.

As regards the statistical part of my work, its very nature confined it to the gathering of the data which are absolutely necessary for judging of the value of the present Bohuslän herring fisheries, and to the study of such statistics relative to foreign fisheries as might aid in throwing more light on the subject in hand.

3. Various methods pursued in the herring fisheries.

Of far greater interest to the general public, and much better known, have been my labors relative to the methods of carrying on the herring fisheries on the coast of Bohuslän. The different views as regard the best method of carrying on these fisheries have led to a lively interchange of opinions, in which my views have met with most favor, although they could not afford the fishermen any pecuniary assistance from the public fund. All I have aimed at was to influence public opinion and thus to exercise a good influence on the development of the fisheries, which unfortunately cannot be said of the endeavors of my opponents.

As I had no means of introducing by way of experiment new fishing apparatus and methods, I had to confine myself to point out, principally

by statistical data, the different economic advantages of the various methods and apparatus. The same formed the object of Prof. S. Nilsson's and other prominent scientists' studies half a century ago. They started, however, from the supposition that, as regards the method employed, the herring fisheries on the south coast of Sweden could hardly be excelled. Their ideas were very correct, however, as to the desirability of the Bohuslän people retaining their method of seine-fishing, unless they were forbidden to do so; the consequence was the prohibition of such seines for the herring fisheries by paragraph 22 of the fishery law of 1852. Their opinion that nets are absolutely preferable for the herring fisheries has been refuted by me, when I showed that different economical and physical conditions may necessitate the use of different apparatus and methods of fishing, and that because a certain apparatus or method is the best in one locality one is not justified in supposing that it should apply to every other locality. I have furthermore called attention to the enormous difference between fisheries on a large and a comparatively small scale, and have shown that even fisheries of the latter kind may pay in those parts of the coast of Bohuslan where, owing to the small quantity of fish, the prices are very high. In the very beginning of my labors I was enabled, guided by statistics from Scotland, to show the absolute necessity of equipping large and more powerful boats and furnishing them with superior apparatus, if the seine fisheries in the Skagerack were to yield good results, and have pointed out this necessity in my memorial to the minister dated in February, 1878. Seine fisheries carried on during autumn and winter in the open sea require strong boats and numerous seines, so that the quantity of fish in the various hauls may make up for the naturally smaller number of chances to make hauls, and that the number of these chances may be increased by the use of strong boats and superior apparatus as is done by the Yarmouth fishermen and others. All this, however, requires more capital than our fishermen can command at the present time; great herring fisheries with seines cannot be developed all at once, not only because they require much capital, but also competent men to lead the fishing expeditions, and experienced sailors and fishermen. The German experiments at Emden show how much time it takes to develop such fisheries to any considerable degree of importance.

I have never, as Professor Smitt seems to intimate, worked against the introduction of seine fisheries, but all I have done was to publish reports, for the benefit of the public, on the relative advantages of the different kinds of apparatus, and in this connection I have pointed out the facts that seine fisheries on a large scale required, not only much capital, but also so large a number of fishermen, that on the coast of Bohuslän we would have to take them away from other trades; that the development of the Bohuslän fisheries, starting from the present method and aiming at such fisheries as are carried on on the northeastern coast of America, would be most desirable under the existing circum-

stances. The American method of carrying on the fisheries, with large and fast vessels and seines, promises to us profitable fisheries, and to especially develop the herring fisheries in such a manner that, instead of drawing the fishermen away from the great sea fisheries, and thus hurting them, they will, on the contrary, be furthered and increased to a degree of prosperity hitherto unknown with us.

Professor Smitt has several times reproached me that by my experiments I had endeavored to introduce large seine fisheries for herring in the Skagerack, and declared that our population would thereby suffer considerable losses, to which I could boldly reply that I did not have a single cent at my disposal for making such experiments.

As the terms "great fisheries," "great sea fisheries," and "fisheries at a distance from the coast" (*utomskärsfiske*) refer to very different kinds of fisheries, and should not be confounded with each other, I shall give a brief explanation of their meaning. As the "fisheries off the coast" are carried on under such circumstances that the fish cannot be taken home every day, but must be either kept or prepared on board the vessels, or delivered to other vessels out at sea, they are called "great sea fisheries." "Great fisheries" are those sea fisheries which are carried on on a large scale in the service of private capital, as is the case with the seal and whale fisheries. "Great fisheries" can be carried on both at a distance from the coast and near it. As "great fisheries" at a distance from the coast, we may mention the great Dutch herring fisheries in the North Sea, the beam trawl net fisheries in the North Sea, the French and English cod fisheries near Iceland, &c. As "great fisheries" near the coast, we may mention the former herring fisheries of the Dutch and Germans near the west coast of Scandinavia, the former Dutch herring fisheries on the west coast of Scotland, the herring fisheries of the Northmen near Iceland, &c. Coast fisheries can be carried on both near the coast and at some distance from it, as the natural conditions will allow. The most important coast fisheries in Europe are the Scotch herring fisheries, and the Norwegian cod fisheries near the Lotfoden.

I have endeavored to benefit the herring industry, as regards the catching and salting of the fish, and as regards the results of the fisheries, by publishing a review of the influence, on the migrations of the herring, of physical conditions.

As regards the preparation of herring and the herring trade, my activity has, likewise, from want of funds, been limited to the publication of several pamphlets, by which I have endeavored to create a public opinion in favor of the introduction of suitable improvements in the methods of preparing fish, and of proper laws for aiding and encouraging this trade.

Thus, at the very beginning of the present fishing period, I made translations of Th. D. Lauder's and O. N. Löberg's works on the preparation of herring, and pointed out the great importance of having that portion

of the public which is interested in this question supplied by the Government with a sort of a text-book giving in a brief and concise form all the necessary instructions for successfully carrying on this industry. My translations were printed in a Swedish paper, and likewise in pamphlet form for distribution among the population of the Bohuslän coast. Later, I prepared and published some pamphlets on the pickling and salting of herring, on the herring trade, &c., with the view to awaken new interest in this trade, and in the hope that by introducing improved methods this industry might be further developed, not only as regards the sale of fish, but also as regards the introduction of improved apparatus, &c. In consequence of my endeavors, the Economical Society called in some Scotchmen to teach our people to salt herring after the Scotch method. In May, 1882, I was allowed 1,200 crowns ($201.60) for a journey to Scotland, which I took the following summer. I studied the Scotch preparation of herring on the spot, and, on my return, publishing an account of my trip and of the observations made.

Relative to the herring trade I have commenced extensive studies, to complete which I should, however, undertake several journeys abroad. What I have published in this direction is, so far, the only systematic review of the subject.

4. CARE OF THE HERRING FISHERIES.

The question as to the care of the Bohuslän herring fisheries has for a long time, and I think unnecessarily, been a disputed one. By the care of a fishery we understand the measures which are taken to make the fishery as productive and permanent as possible. This care may be exercised by the state, by proper legislation and administrative measures, or by private effort, in preparing spawning places, or making such places accessible by fish culture, taking care of the young fish, &c.; it may be exercised in a negative manner by preventing any disturbance of the spawning process and the use of hurtful apparatus, and by limiting fishing as to time and place, &c.

When the great Bohuslän herring fisheries came to a close in 1808, and when those persons who had invested in expensive apparatus suffered heavy losses, producing unheard-of suffering on the coast of Bohuslän, it was natural that people began to think and speculate a great deal on the causes of this misfortune, and on the possibility of seeing these fisheries revived. Among the more educated people the view became prevalent, especially after they had become convinced that the "sea herring" proper had left the Skagerack, that the herring had been chased away by exhaustive fishing, by noise, and by throwing fish-oil refuse into the water. This view was publicly expressed in a pamphlet published by a salter in 1822.

This, and the repeated demands for pecuniary assistance from the Government to aid the fisheries and the poor fishermen, at last induced the

Government to order a scientific investigation with the view to get reliable information as to the actual state of affairs. This investigation was entrusted to Professor Nilsson, who visited the coast of Bohuslän during the summers of 1826, 1827, 1832, and 1833. In his reports Professor Nilsson gave in their main outlines the views given above as to the causes of the herring fisheries coming to an end, and thoroughly refuted (as to some extent M. E. Bloch had done before him) the hypothesis advanced by Dr. J. Anderson, of Hamburg, Germany, that the herring had their home near the North Pole, and migrated thence; but in his zeal he went too far in the other direction, by considering the herring as a fish which is confined to the place of its birth and its nearest surroundings. He further thought that by outward differences of race the herring showed from what part of the sea they came; and, therefore, as "two different races of the same kind" could not be supposed to "live in the same waters, and under entirely the same conditions," the so called "old" herring, or "sea herring proper," the somewhat smaller coast herring which spawns in spring, or the so called "spring herring," and the medium-sized herring which is caught in large quantities during winter, must all be of one and the same kind, belonging to the Skagerack, and thereupon he based his well-known opinion, that by good management, and by taking proper care of the fisheries, new great herring fisheries could be produced. Professor Nilsson thought that all that was necessary to reach this end was to abolish the use of seines, and, as is done on the coast of Holland, to use only stationary nets. Most scientists at the time agreed with these views of Professor Nilsson.

The coast population, however, as well as the authorities of Bohuslän, very emphatically opposed these views of the scientists. Thus it was constantly said that the "old" sea-herring were of a different kind from those herring caught later in small quantities, and that even if the use of seines was prohibited, with the view to spare the small herring, the catches of full-grown herring would not be any larger. Special care was taken to prove that the line-fisheries would suffer if the seines were abolished, because there would be a lack of bait.

These two objections were, of course, met, and, according to the demands of the time, apparently answered by the scientists, who also made several suggestions as to the best way of meeting the demand for bait.

After about twenty years had passed, during which this controversy was going on, the Swedish Parliament, on the 25th August, 1844, on the motion of Mr. Hjort, a member from Bohuslän, passed a resolution that the Government should be requested to put the views of the scientists to some practical use; which resolution, also favored by the Royal Academy of Sciences, led to the new fishery law of June 29, 1852. The provisions of this relative to the care of the herring fisheries were, however, not at all carried out, at least on those coasts where

herring had been caught with nets and seines from time immemorial, and where these fisheries were of considerable importance.

A month previous to the promulgation of this law, which is still in force, the Norwegian Government had an investigation made on the south coast of Norway near the Swedish frontier, with the view to improve the sea fisheries. This investigation, in which, amongst the rest, Prof. H. Rasch took part, led to very different views from those entertained in Sweden. Thus, it was shown that the large seines were comparatively harmless, but that the small seines exercised a hurtful influence on the fisheries. This investigation was of great importance to Sweden, as it was carried on very carefully and in the most exhaustive manner, and along a coast which comes close up to the Bohuslän coast, and greatly resembling it.

The authorities at Gottenburg, therefore, asked the Government to annul the provision of the fishery law relating to the use of seines, basing their request on the opinions of Norwegian naturalists, such as O. N. Löberg and Axel Boeck.

During the first two years of my investigations I treated in the most thorough manner possible the question as to the care of the herring and sprat fisheries, and the alleged help extended to them by prohibiting the use of large seines with narrow meshes, and showed that the strict carrying out of this provision would be hurtful rather than helpful. To prove still more fully that the old views were entirely untenable, I pointed to the regular secular periodicity of the great Bohuslän herring fisheries. The return of a new herring period during the winter 1877–'78, although during the ten preceding years fisheries had been going on with large seines having narrow meshes, utterly refuted the old theories on which the provision in question was based.

As regards the secularly periodical fisheries, it would hardly be possible to exercise any special care, as the inroads made by man are very insignificant compared with the enormous masses of herring. Only during that part of the herring period when the herring approach the coast for the purpose of spawning, one should see to it that they are not hindered from going to their spawning places, and that the spawning process is not disturbed by seine fishing. The seine fisheries near the coast cannot be said to have had a hurtful influence on the propagation of the herring, as they do not disturb spawning or hinder fish from approaching the spawning places; they only yield herring which have spawned some time previous, or such as have not yet reached their sexual maturity. Objections may be made to any kind of apparatus no matter how innocent, but in fisheries of such enormous dimensions as the great Bohuslän herring fisheries such objections have no weight.

As regards the permanent small herring fisheries carried on on the coast, something might be done by exercising proper care, and Bohuslän has already, in the regulation of June 19, 1872 (prohibiting small seines with narrow meshes), a suitable legislation in this regard, which, if prop-

erly observed, may do good, or at any rate prevent a good deal of damage. All unnecessary destruction of the fry must, as a general rule, be considered as hurtful, and should, therefore, as far as compatible with the proper supply of bait, be prevented. But such legislation cannot be carried out successfully in the waters near the Norwegian boundary line, unless similar regulations are adopted on the Norwegian side.

The complaints of the decline of the Bohuslän *fiord* fisheries are very old, and it would be necessary to take careful statistics of these fisheries for a considerable length of time, in order to determine whether these fisheries are to some extent periodical, or whether the decline is owing to the lack of proper care.

It will hardly be possible to improve the herring fisheries by artificial impregnation, or to increase the quantity of herring food by throwing organic matter into the water near the coast, as Prof. A. W. Malm proposes. All such propositions must be considered as impracticable attempts to manage the small and unimportant fiord fisheries on the same plan as the entirely different enormous sea fisheries.

5. Legislation regarding the herring fisheries.

I have made extensive historical and comparative studies with the view of obtaining a basis for special legislation for the Bohuslän herring industry and the other Bohuslän sea fisheries, which, however, should be continued and completed, to meet the demands of the times.

The right of fishing, especially in Bohuslän, has been made the subject of thorough investigations by me, which have finally led me to conclusions far different from those generally entertained. The right of the Crown to the herring fisheries has thus been shown to have been maintained in olden times, and to some extent in the present time; this right has been shown to have referred to the secular periodical fisheries.

I have pointed to the necessity of laws to regulate the herring trade, have called attention to the lack of a fixed measure for measuring the fresh herring, and have advocated that, as regards the herring barrels, a certain minimum size should be fixed.

I have made very extensive preliminary studies not only with the view to become acquainted with all the old Swedish laws relating to the sea fisheries, but also to prepare new laws for these fisheries.

6. Administration (supervision) of the herring fisheries.

As regards the gathering of the necessary material for drawing up a plan for the administration of the Bohuslän fisheries, I have also done something, principally by making extensive and comparative studies of all the subjects bearing on this question. The studies should, however, be continued and extended by making observations in foreign countries. With the view to encouraging the authorities to lend their aid towards the development of the Bohuslän herring fisheries, I made a motion at

the meeting of the Gottenburg and Bohuslän assembly (legislature), in 1882, that the Government should be petitioned to appoint a special board of directors of the Bohuslän sea fisheries, to reside in the district. This motion was adopted; and a Gottenburg paper contained several articles by me, in which I defined the activity of this new board, and for comparison's sake gave an account of similar institutions in Scotland and Holland.

I gave a full account of the manner in which the official examination of herring in Scotland is carried on, and of the measures formerly taken in Holland in this direction. By numerous newspaper articles I have endeavored to urge the present administration of the Bohuslän fisheries to greater activity, and some extent I have been successful.

One of the principal causes of the unsatisfactory condition of the Bohuslän fishery administration must be sought in the great expositions, which have had a demoralizing influence, and have fostered a dangerous "Chauvinism," the rooting out of which is as difficult as it is essential to the introduction of an improved condition of affairs. I have, therefore, as far as it lay in my power, endeavored to give our people a more correct idea of the true value of these expositions, which are repeated too often, and which take away far too much money from more useful purposes.

7. Care of the fishermen and improvement of the coast.

I have also done considerable preliminary work towards preparing a complete social and scientific exposition of the best manner of taking care of the herring fisheries, and of advancing the true interests of the Bohuslän coast. During the ten years which I have spent in Bohuslän for the purpose of making observations, I have, as far as lay in my power, worked, by writing and speaking, to improve the economical and social condition of the Bohuslän coast.

As regards advancing the interests of the Bohuslän coast by the Government, I have, partly by motions in the Economical Society of Bohuslän, in the Bohuslän Assembly, and the National Parliament, and partly by addressing petitions to the Government, endeavored to improve the social conditions of this district by having aid extended to the sea fisheries; and I am happy to say that some of my efforts have been crowned with success. I have particularly pointed out the necessity of concentrating the fishing industry in favorably located and well-governed towns, and of taking proper measures for preventing, as far as possible, the numerous and great troubles which followed the close of the herring period during the last century.

But as individual efforts are considered as essential in aiding the Government in its endeavors to further the interests of the fisheries, I drew up a plan for an "Association to promote the Bohuslän fisheries," and during last year's fisheries issued invitations to form such an association, which was done in October last.

8. Economical value of the herring fisheries.

As regards, finally, the preparation of a national economy of the herring fisheries, which is of great importance for this whole question, I have also made extensive studies, which I hope to embody in some work on this subject.

That I should meet with many difficulties was, of course, to be expected, but this did not deter me from continuing my studies, especially after I began to realize that the principal mistake of those who had, before me, given the herring question some attention was that they had overestimated the importance of the descriptive treatment of the natural history of the herring, and had neglected the economical aspect of the question.

XIX.—THE OSTEOLOGY OF AMIA CALVA: INCLUDING CERTAIN SPECIAL REFERENCES TO THE SKELETON OF TELEOSTEANS.

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The present paper will be divided into two parts; of these, Part I will consist of a translation of the admirable article of Dr. M. Sagemehl, entitled "*Beiträge zur vergleichenden Anatomie der Fische*," the first contribution given us being "I. *Das Cranium von Amia calva*, L." This carefully written essay appeared in the second part of the ninth volume of the *Morphologisches Jahrbuch*, for the year 1883. It is illustrated with one double-page, beautifully executed plate. The twelve figures in this plate I have had, through the kindness of Professor Baird, carefully copied by Mr. H. L. Todd, the artist of the Fish Commission and Smithsonian Institution. They appear in their proper places in the plates illustrating this article with their explanations set opposite to them.

In Part II it is my intention to review the conclusions arrived at by Bridge, after his study of the skeleton of this interesting form. This anatomist published his well known memoir in the Journal of Anatomy and Physiology (Vol. XI, 1877, pp. 605–622, Plate XXIII), six years before Dr. Sagemehl's results appeared in the *Jahrbuch*. In this part, too, I will bestow a passing glance upon the monograph of Henricus Franque,[1] and compare his figures with those given by the above authors. Beyond this, however, it is not my intention to pass further into the literature of the subject, as the short and unsatisfactory accounts given by the older writers would avail us nothing here. Finally, I propose to present a few observations of my own, which have been the result of an examination of a skeleton of *Amia*, carefully prepared from a specimen of this fish which I captured in the vicinity of New Orleans, La., during the summer of 1883. This preparation was done for me in the most skillful manner by Mr. J. L. Wortman, the anatomist of the Army Medical Museum, of Washington. A few figures will be presented in this part, illustrating points that do not appear in Dr. Sagemehl's article.

[1] *Amiæ Calvæ Anatomiam*, Berolini, 1847.

PART I.

Ever since 1845—when Carl Vogt[2] demonstrated that *Amia calva*, L differed in the structure of its heart from all known bony fishes, being like the cartilaginous fishes in this respect; and since Johannes Müller,[3] noting this circumstance, separated this remarkable fish from the Clupeoids, with which it had formerly been classed, adding it to his and L. Agassiz's established sub-class of Ganoids—the attention of anatomists has been steadily directed towards this form.

A number of works touching upon nearly all parts of the anatomy of *Amia* have made their appearance, so its structure is at present better known than that of most bony fishes. It is quite remarkable that the cranial anatomy of this Ganoid has not received proper attention, as it is by no means a rare fish in collections. The memoir by Bridge,[4] published in 1877, is in my opinion the only one in which the subject has been at all fully described.

Upon the suggestion of Privy Counselor Professor Gegenbaur, I undertook the task of re-examining the crania of the Teleostei, especially in the Physostomi and the Anacanthini, and in looking for a form in which the various differences in the structure of the skull could best be judged, my attention was drawn to *Amia*. In fact, a careful study of the cranium of this fish showed that several diverging series of skull-types could easily be traced from it. On the other hand, the task of tracing the conditions of the cranium of the Teleostei from more simply constructed types—such as the Selachians offer—I found the *Amia* to be an excellent transitory form for the purpose. The careful descriptive work of Bridge, with whom I concur in the majority of points, so far as the actual conditions are concerned, does not suffice for this special purpose. Certain points of organization, which at the first glance appear to be incorrect, and the significance of which only become apparent after comparisons with other forms, he has left entirely unnoticed. Furthermore, in his descriptions he has kept strictly within the limits of his title, perhaps for lack of material, describing only the bones of the skull and entirely neglecting the surrounding soft parts, in which I recognize the necessary elements to complete the configuration of the skull. Finally, in my opinion, Bridge has not been fortunate in his descriptions of several of the bones of the skull in *Amia*.

Taking all this into consideration, I decided to present a comparative description of the skull of *Amia*. At the same time I believe I will be

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[2] *Annales des Sciences Naturelles*, T. IV, 1845. (I have changed the numbering of Dr. Sagemehl's foot-notes so as to accommodate them to the present article.—TRANS.)

[3] *Über den Bau und die Grenzen der Ganoiden. Abh. d. k. Akad. d. Wissenschaften z. Berlin vom Jahre* 1844. *Berlin*, 1846. *Nachschrift*, pag. 204.

[4] The Cranial Osteology of Amia calva. Journ. of Anatomy and Physiology, Vol. XI, 1877, pages 605–622.

able to discuss several questions of a more general nature, which are of prime importance when taken in connection with my work upon the crania of the Teleostei, soon to be undertaken. It only remains for me to justify myself for having confined myself in this work, as I will in those of the future, strictly to the cranium, and for having but touched lightly upon those parts of the visceral skeleton connected with it; and that, too, only so much of it as was necessary to complete the form of the skull. Such partiality would hardly be justifiable were one considering the forms the cranium assumes in the higher vertebrates.

This is entirely different in the class Pisces. The visceral skeleton here has, in so far as the cranium is concerned, preserved a certain independence, and in consequence its form has been much less influenced, less so than other organic systems, as for example the nervous system, the muscular system, and particularly the organs of sense.

There is yet another objection that might be brought forward, and that is, that I have paid but little attention to the literature of the subject, particularly the older literature. In my allusion to facts long known—and, as I assume, of facts well known—it seemed to me entirely superfluous to continually cite authorities. Such a course would have rendered my subject-matter diffuse and unwieldy, without adding anything useful. The literature relating to it, contained in the more recent and less known works, and which refers to the discussion of purely special points, I have in every instance conscientiously cited.

Through the unbounded liberality of Privy Counselor Mr. Gegenbaur, to whom I here express my profound thanks, I have been enabled to examine five specimens of *Amia*, the smallest of which was 36^{cm}, the largest 57^{cm} long.

In viewing an unprepared head of *Amia calva* one can already distinguish the superficial plates of bone that overlie the cranium, they being merely covered by an extremely thin cutis.[5]

The sculpturing of the superficies of these bony plates is quite characteristic, consisting of sharply-defined and numerous ridges, which start from the center of each bone, to radiate outwards to the peripheries. After the thin skin covering them has been carefully removed one recognizes the limits of the several bones with requisite distinctness. Three pairs of bony tables, situated one behind the other, first meet the eye, of which the foremost possesses the greatest and the hindmost the least longitudinal extension.

The foremost of these pairs of plates consists of two bones, each of a quadrilateral outline, being joined together mesially by a strong dentated suture. (Plate I, Fig. 1.) The lateral borders of these bones arch over

[5] If Bridge (*loc. cit.*, page 606) describes the surface of these bones as "highly polished," and further says "they are destitute of any covering of soft skin," he is in error. One can easily convince himself, from a microscopical examination, that all of these overlying plates of the skull in *Amia* are not only covered by an epidermis—which is also present is *Lepidosteus* and *Polypterus*—but undoubtedly also possesses a very thin covering of cutis.

the orbits, while their anterior lateral angles rest upon the antorbital processes. In view of this arrangement this pair of bones are characterized as the *frontalia*[6] [frontal plates].

Behind these two bones, follow two others of an approximately quadrilateral outline, which like the preceding pair are connected together in the middle line by a dentated suture. These are undoubtedly the *ossa parietalia* [parietal plates], which in *Amia*, as in several other bony fishes, are suturally united mesiad[7]. (Plate I, Fig. 1.)

On either side of the parietalia and of the posterior part of the frontalia is found a longitudinally placed bone (Plate I, Fig. 1, *Sq.*), which corresponds in all respects with the *os squamosum* of the Teleostei.[8]

Articulating with its hinder border with the squamosal on either side, and being situated at about the middle of the latter half of the frontal, we observe another osseous plate, with its long diameter placed longitudinally. It is the osseous plate that overlies the continuation of the post-orbital, and is the post-frontal (Plate I, Fig. 1, and Plate II, Figs. 5 and 6, *Psf.*). A similar, only smaller, bone-plate, extensively sculptured, articulates with the anterior lateral angle of the frontal, and is the superimposed plate that represents the prefrontal (Plate I, Figs. 1, 2, and 3, *Prf.*). While the bony plates just described are firmly articulated with one another, and are also in intimate relation with the true cranium beneath, or are even blended with it, the two rather small osseous plates (Plate I, Fig. 1, *Ex.*) situated behind the parietals and squamosals, and meeting each other in the middle line,[9] are connected only with the bones in front of them by means of dense ligamentous bands. Nor

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[6]As regards the determinations of these bones, I have adhered strictly to the names used for them by Gegenbaur. It is of course universally known that these names, now long in use, do not express any homology whatever with the correspondingly named bones of the higher vertebrated animals. I am of the opinion that a complete homology exists for only a very few of the bones of fishes when compared with those of the higher vertebrata. There is not positive proof for a single one of them at the present writing. The most rational thing to do under the circumstances would be to introduce, if possible, a new and neutral nomenclature for the bones of the skull in fishes; yet I did not think myself justified in introducing such an innovation, which at any rate, so long as an exhaustive knowledge of the bones of the skull in fishes is not complete, could only be provisional, and I have therefore contented myself with the old names.

[7]Bridge, on whose specimen this mesial suture between the *Paritalia* had worn away, bestows, in consequence, upon the blended bony plates the name of "dermosupraoccipitale," a name which in any event is inadmissible. On seven specimens of *Amia*, examined by me for the special purpose of looking into this condition, I have invariably found the median suture to be present, agreeing in this particular with the descriptions given by Owen and Franque, and I must consider the condition as found by Bridge as an individual anomaly, to which no further significance need be attached.

[8]Bridge takes this pair of bones for the parietalia because they lie upon either side of his dermosupraoccipitale.

[9]If Bridge intends to convey the idea that these plates do not meet each other in the middle line, he is in error; his own drawing (Plate XXIII, Fig. 1) proves to the contrary.

have they anything whatever to do with the primoidal-cranium, and they are even separated from the exoccipitals by connective tissues, though they overlap these bones to some extent. The greater part of one of these bones laps over one of the bones of the shoulder girdle, which latter rests with a mesially-directed process upon the hinder border of the exoccipital, while its remaining process, directed forwards, is attached by a strong ligament to the intercalare. This bone (Plate I, Fig. 1, *Sc.*) corresponds in all respects with the suprascapula[10] found in nearly all of the Teleostei.

Among the Teleosteans one quite constantly finds, between the processes of the suprascapula, a very superficially-situated dermal bone, which was first differentiated by Stannius from the supratemporal bone, which articulates laterally with the squamosal, and has been termed the extrascapula. This bone usually is not very large, yet in a few cases, as for example in *Macrodon*, it attains quite a considerable size; it then resembles in a great measure the bone as just described for *Amia*, and it is only to be distinguished from it in that it does not meet its fellow in the middle line. One will therefore hardly go astray in regarding the bone in *Amia*, designated in Plate I, Fig. 1, as *Esc.*, as homologous with the extrascapula of the bony fishes.

The nasal region of *Amia* is covered by five small dermal bones, which are separated posteriorly from the frontal plates by a small transverse strip of cutis.

The dermal bone (Plate I, Fig. 1, *Eth.*), placed most anteriorly of this group, has the form of an equilateral triangle, with the apex directed backward, and with a somewhat spreading base. It lies more deeply seated in the skin than the rest of these bones that overlie the cranium, but nevertheless it shows traces of the sculpturing that characterizes them all. Posteriorly, and to either side of this unpaired osseous plate, lie a couple of small bones (Plate I, Fig. 1, *Na.*) of which the two medial ones are somewhat the larger pair. These are separated anteriorly by the azygos bone, just referred to, penetrating between them; behind, they meet each other in the median line. On either side of these dermal bones lie two smaller ones (Plate I, Fig. 1, *An.*), of which no special notice need be taken. The four bones just described, more especially the medial pair, form the covering to the nasal cavity. Among the three bones designated by *Eth.*, *Na.*, and *An.* there remains, where they come together anteriorly, a small opening which leads to the rhinal chamber, and corresponds to the anterior nasal aperture of *Amia*. The posterior nasal opening is far removed from the anterior, being situated at the posterior lateral angle of the bone designated by *Na.* The interpretation of the dermal plates just described is not difficult.

The two posterior medial dermo-bones, holding, as they do, a position in front of the frontals and above the narial depressions, correspond or answer to the nasal bones of osseous fishes. There is yet another con-

[10] Suprascapula of Cuvier; omolita of Geoffroy and Stannius.

dition of these bones that supports this statement, viz, their relation to the mucus canals of the head.[11]

Among the Teleostei the anterior branch of the mucus canal, imbedded in the frontal bone, begins with an opening which is situated to the inside of the anterior nasal aperture. Its course in the nasal is backwards, and then it passes through the frontal, in which it throws off several side branches.

This portion of the mucus canal bears exactly the same relations to the bones in question in *Amia* as in the nasal among the Teleosteans, as may be seen by referring to Plate I, Fig. 1.

The mucus canals can also be utilized in defining both lateral bones. The main branch of the mucus canal, imbedded in the same, unites with the canal of the suborbital arch, and only a small lateral branch anastomoses with the mucus canal of the frontal. This condition reveals the fact that the bone just mentioned must be the first piece of the suborbital arch somewhat removed from its usual position—the antorbital.

The middle non-parial piece can also be determined without difficulty. In it we see a rudimentary ethmoid which has abandoned its customary site and relations with the frontalia, owing to the unusually developed nasal bones. So Bridge has likewise considered it; in fact, one could hardly regard it in any other light, unless choosing the very improbable assumption that the ethmoid—very constant elsewhere—is entirely absent in *Amia*, and that this fish is provided with a peculiar prenasal bone that never occurs in other fishes. Our determination is undoubtedly correct, as we find in *Polypterus* an identically similar bone, though here it is connected with two small processes of the frontalia that enter in between the nasals.[12]

All of the bones just described that overlie the cranium, with the single exception of the prefrontal, are pierced by a system of mucus canals, which are worthy of a closer consideration (see Plate I, Fig. 1).

As already mentioned above, a large mucus canal commences, mesiad, by the anterior nasal aperture to follow a course first in the nasal, then through the entire length of the corresponding frontal, to terminate in the extreme anterior portion of the parietal, on the surface of which its mouth is to be found.

The right and left canal are connected anteriorly by means of a transverse anastomosis which passes through the ethmoid. During its course through the posterior part of the frontal the mucus canal just described throws off a lateral branch, which passes through the postfrontal, and, being confined between the bones of the orbital arch, passes around the

[11] I desire to mention, at this point, that hitherto the relation of the mucus canals to the bones of the cranium have hardly been given a thought, and yet they deserve a closer study, as these relations are very constant, and in questionable cases they can be used to determine doubtful homologies.

[12] Cf. the representation of Müller, Structure and Limits (*Grenzen*) of the Ganoids, Pl. I, Fig. 1.

eye, reaches the preorbital, and terminates laterally near the anterior nasal aperture.

From the mucus canal leading to the orbital arch another canal takes origin, beginning in the frontal, passing through the entire length of the squamosal, to enter the extrascapula and suprascapula. After passing through the suprascapula it becomes the mucus canal of the lateral line, passing on to terminate at the tail. Both of these canals, just referred to, are united by a transverse anastomosis, which is imbedded in the substance of the extrascapula. During its course through the squamosal a branch directed laterally arises from this canal. This branch enters the preoperculum, passing through the entire length of this bone to enter the mandible beyond, and eventually join the fellow of the opposite side, which it meets at the symphysis. All these mucus canals send off numerous ramifications of smaller canals, arranged in several longitudinal rows, which terminate on the surface of the head in minute openings.

Taking into consideration their superficial location, the peculiar sculpturing of their surface, and the possession of mucus canals, the bones we have just described are unquestionably characterized as ossifications of the skin—as dermal bones. In making any attempt to remove these dermo-bones one recognizes the fact that their relations to the chondrocranium are very different.

The ethmoid, the nasals, and the preorbitals[13] do not come in contact at all with the same, but are separated from it throughout their entire extent by soft parts.

On a microscopical examination of cross-sections made from one of these bones (take for example the extrascapula) one can distinguish a superficial layer from a deep one. The latter consists of osseous lamellæ, which are piled up parallel with the bony plane, and which are interrupted by others, arranged concentrically around the Haversian canals.

This deeper bony layer gives passage to quite a number of capacious Haversian canals and is supplied pretty generously with bone corpuscles. The superficial layer of these dermal bones is characterized, when compared with the one just described, by a much denser tissue, by a small number of Haversian canals, by an almost entire absence of bone corpuscles, and, what is most important, by the existence of numerous and very minute dentine tubelets (*Dentinröhrchen*) which penetrate it from the surface of the bone. Yet I wish to explicitly state that one cannot make out the exact boundary between these two layers with any certainty.

The frontals, parietals, and squamosals are in more intimate relation with the skull. In part, these are quite closely connected with the cartilaginous cranium, and are separated from it simply by a layer of thin connective tissue. Histologically they remind one very much of the

[13] This applies also to the extrascapular, the suprascapular, and the supraclaviculas.

bones of the first group. The two osseous layers can also be distinguished in them, but the inferior one is better developed and more plentifully supplied with Haversian canals, so that it becomes quite spongy in character. As already stated, they are separated from the underlying cartilage by a thin layer of connective tissue, through which ramify a numerous set of vessels, and in which are found pigment cells.

Finally, the postfrontals and prefrontals present us true "primary" ossifications of the primoidal cranium, which cannot be removed without injury to it, and which only remind us of their original development as dermal bones by their superficial location and by their sculptured surfaces, the former also by their having mucus canals.

The conclusion which we arrive at after our examination of these two bones in *Amia*, and which they afford, is so unique and so unlike the usual conditions that characterize those specific differences between dermal bones and the ordinary ossifications of the true skeleton, that it is easily perceived how Bridge was induced to separate each of these bones into two components, and to distinguish the true—corresponding to the homologous bones of the Teleostei—prefrontal and postfrontal, as well as the "dermoprefrontal and dermopostfrontal," covering the same. An unprejudiced examination at once convinces us that the conclusions arrived at by Bridge do not agree with the actual condition of things. The plates of these bones, visible on the surface of the cranium, as well as the outer layer of all the other dermal bones, undoubtedly consist of a compact and very hard bony substance, while those parts which are more deeply situated are more cancellous in texture; still the transition of one to the other is gradual, and the superior plate cannot be removed without breaking the bone.

Here a rare case presents itself—up to the present time almost universally doubted—in which bones that on their surface present all the characteristics of dermal bones have acquired relations with the true skeleton through their more deeply situated parts or structure, and in consequence are in part dermal and in part true bones.

Another group of bones is to be seen—partly, also, without dissection—from the cavity of the mouth. Lying in the median line and longitudinally placed upon and belonging to the parasphenoid is an osseous strip that is entirely covered over with a growth of firmly implanted and small conical teeth.[14] Between these teeth the bone is covered by a very thin layer of mucous membrane, which is only to be discovered after careful search.

Situated anterior to these median bony strips, there is on either side a number (from 17 to 22) of strong conical teeth, which are supported by the vomer. As the interstices among these teeth are filled in by a thick mucous membrane, nothing can be seen of the bones from an

[14] Wher Bridge speaks of roughness (asperities) of the parasphenoid, he does not convey to us the correct idea or condition. This roughness is caused by these true teeth, and of this fact Franque was already cognizant.

external view. Similar bone-plates, provided with fine little teeth, such as those just described for the parasphenoid, are found upon the palatine, upon the three pterygoids, and upon the splenial of the mandible. After the excellent investigations of Leydig[15] and O. Hertwig[16] a particular reason is hardly required if I place the parasphenoid and the vomer, as ossifications of the mucous membrane of the mouth, opposite the dermal ossifications and the true ossifications of the skull.

In respect to this, it seems to me that the condition found to exist in *Polypterus* is of peculiar significance; in this form, according to Leydig's investigations, all the bones of the buccal cavity are covered over by the epithelial layer solely. The *Amia*, where the ossifications beneath the epithelium are likewise covered by a layer of connective tissue, constitutes an excellent example, so far as this condition is concerned, of the transition stage between this form and the majority of bony fishes, in which the parasphenoid and vomer are hidden beneath the thick mucous membrane of the mouth.

After the cranium has been skeletonized, the parasphenoid and the parial vomer can be easily discerned.

The *parasphenoid* (Plate I, Fig. 2, *ps.*) is a flat bone, having the form of a cross. Its stem extends from the hindermost extremity of the skull to the antorbital, and very near its middle it gives off two branches, which extend laterally and upward alongside the postorbital, and form the posterior boundary of the orbit.

The posterior extremity of the parasphenoid is deeply cleft, thus allowing a small triangular portion of the basi cranii, represented by the basioccipital, to come into view upon a basal aspect of the skull. That part of the bone which is provided with teeth, and which in different individuals varies with regard to its anterior and posterior extension, lies mesially between the two branches.

In front of the parasphenoid are found the two *vomers* (Plate I, Fig. 2, *vo.*), articulating with each other in the middle line. They are flat osseous plates, placed longitudinally, with their anterior thirds armed with stout teeth. Their posterior moiety covers the anterior part of the inferior aspect of the parasphenoid.

If the statement that the parasphenoid originally bore teeth over its entire surface be correct—and so many facts have been adduced in its favor that its correctness can hardly be doubted—the overlapping of the vomer on this bone must be a primitive state of affairs. In fact, if one compares this condition of *Amia*, with its parial vomer, with the arrangement in bony fishes, where the vomer is known to be always nonparial, hardly a doubt but that *Amia* represents the primitive condition remains.

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[15] W. Leydig, *Beitrag z. mikroskop. Anatomie v. Polypterus. Zeitschr. für wiss Zool.*, Bd. V.

[16] O. Hertwig, *Das Zahnsystem der Amphibien f. mikroskop. Anatomie.* Bd. XI, suppl.

Leaving entirely out of consideration the arguments that can be adduced in favor of a progressive development of *Amia* in the direction of the bony fishes, and that the division of a bone into several parts is an hypothetical process, the positive proof has been given us by Walther [17] that the vomer of the pike is a parial ossification. Yet the present position of the vomers in *Amia* is not the primitive one, and in order to get around all difficulties involved in this question we must assume that in still more pristine forms both these bones occupied a position more remote from the mesial line, on either side of the anterior extremity of the parasphenoid, as in many existing Amphibia.

The conclusion arrived at from these inferences—taken in connection with the fact that the vomerine and palatine teeth of fishes are situated in one and the same line, lying in the same arch—gives some coloring to the supposition that the vomers of fishes originally constituted the anterior overlapping segments of the palatine arch, as has been proven by Hertwig for the Amphibia.

To the "cover-bones" of the skull in *Amia* yet belongs another piece, that with other forms is not so intimately related to the primodal cranium. It is the *intermaxilla* (Plate I, Fig. 1, and Plate II, Fig. 6, *Sm.*).

This is to be seen extended upon the cartilaginous base of the rhinal chamber, proceeding backwards from its arched and compact alveolar process; this thin osseous plate encroaches to no small extent upon the antorbital region.

In the posterior portion of the nasal depression this plate is pierced by a large foramen for the passage of the olfactory nerve (Plate I, Fig. 1, *ol.*).

The integrity of the cartilaginous cover of the primoidal cranium of *Amia* is thoroughly preserved throughout, being devoid of fenestræ or other breaches in its substance of any kind whatever.

In outline it resembles a triangle placed longitudinally, with its apex cropped off anteriorly; it is generally level, and marked only by pit-like impressions at the posterior lateral angles, and by a number of projecting processes, which are more or less ossified. The two anterior ones are the antorbital processes (Plate I, Fig. 1), with their ossifications already described—the prefrontals. At about the middle of the skull-cover the postorbital processes project out laterally at each side, together with their ossifications, also described as the postfrontals (Plate I, Fig. 1).

The prominent posterior lateral angle of the primoidal skull is occupied by the intercalare [opisthotic] (Plate I, Fig. 1, *Jc.*).

As we proceed towards the median line from the angle formed by the intercalare we find rising on either side another process, situated not quite so far behind, that is formed by the exoccipital (Plate I, Fig. 1, *Ex.*). Between these processes, formed by the intercalare and exoccipital, ex-

[17] J. Walther, *Die Entwicklung der Deckkurcken am Kopfskelet des Hechtes. Jenaische Zeitschrift f. Naturwiss.*, Bd. XVI, 1882.

tensive fossæ are found on the skull, that extend well anteriorly towards the frontal region (Fig. 1).

As the dermal bones, occupying their respective places, the squamosal and lateral margin of the parietal span this depression as the arch of a bridge, it gives rise to a cavity between the primoidal cranium and its cover-bone, the opening of which is upon the posterior aspect (Plate II, Fig. 6, *tg.*[18]) and into it enters, to be attached to the occiput on either side, a part of the muscle of the dorsum of the trunk.

This depression, which forms so striking a feature of the skulls in the Teleostei, I here propose to name the temporal fossa.[19]

Projecting from the middle line posteriorly there is a short cartilaginous process (Fig. 3, *Oc.*[20]) that occupies precisely the same position that the superoccipital does in the Teleostei. The last-mentioned bone is wanting in the Siluroids and Dipnoi. From the hinder boundary of the vault of the skull it is produced downwards and backwards, and finally is drawn out as a cylindrical prolongation of the same, in which is contained the posterior part of the medulla oblongata and the anterior commencement of the spinal cord.

The occipital region[21] of *Amia* is, so far as a comparison with bony fishes teaches us, remarkably drawn out longitudinally, and this prolongation, the cause and significance of which will be discussed further on, concerns chiefly the region posterior to the foramen for the vagus.

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[18] This is given in the text of the original as *Th.* and I here correct it to *tg.*—TRANS.

[19] This point is the proper one for us to take a careful look into the relations of the squamosal to the primoidal cranium. This bone rests by its lateral border only upon that crest of the primoidal skull which is directed upwards and outwards and forms the lateral boundary of the temporal fossa. Now, although the squamosal in *Amia*, as already stated, is a dermal bone, which appears only to be resting upon the primoidal cranium, it would be impossible to remove it without injury. This is the site it occupies: from the lateral margin of the bone are developed two osseous ridges, which are directed downwards and to some extent towards the median line, and have, when articulated, the two corresponding sharp cartilaginous crests of the skull inserted between them. The lateral ridge of the squamosal, of the two mentioned ones, is juxtaopposed to the lateral surface of the skull, and is carried from the margin of the bone downwards to the hyomandibular articulation. The remaining or mesial ridge lies in the temporal fossa. This condition is significant in so far that among the Teleostei it is only through the lateral margin of the squamosal, that the cartilages are wedged apart, and the firm union of the bone with the primoidal cranium takes place.

[20] This is *Co.* in the original text, and it has been corrected here to *Oc.* In either event it is not quite clear what Dr. Sagemehl intends to indicate, so *Oc.* has been omitted from my letters of reference, as I must believe he refers to *Ol.*—TRANS.

[21] It appears to me more to the point to consider the foramen for the glossopharyngeal and the posterior border of the petrosal as the extreme anterior boundary of the occipital region in the bony Ganoids and Teleostei, and not the foramen for the vagus, as Gegenbaur has done for the Selachians. In the fishes examined by us these two nerves are intimately related to each other, and in rare cases they may even have a common foramen of exit, so that placing them in this or that region would be quite arbitrary. Moreover, in the limitation proposed by me the confines of regions are almost without exception defined by the sutures between the bones, and therefore it becomes unnecessary to award a bone to different regions.

The base of the occiput is occupied by the *basioccipital* (Plate I, Figs. 2 and 3; Plate II, Figs. 4 and 5, *Ob.*). This bone has the form of a mussel-shell, not unlike *Cardium* or *Pecten*. Posteriorly it is shaped like the centrum of a vertebra, and presents for examination a tolerably even and conical excavation, into which the anterior end of the chorda enters. The margin of this excavation is connected by stout ligamentous bands to the centrum of the first vertebra, the anterior side of which appears slightly convex. Articulating with the lateral margins of the basioccipital are the *exoccipitals* (Plate I, Figs. 1 and 3 *Ol.*). These two bones, for the greater part of the posterior aspect of the primoidal cranium, assist in the formation of the lateral region only to a small extent. In large specimens of *Amia calva* they join together in the middle line over the medulla oblongata by means of a suture; in immature specimens they are separated throughout their entire extent by a strip of cartilage. They form no part of the articulation of the neural arch of the first vertebra, but they are separated from it by two bony arches, which rise upon the posterior portion of the basioccipital, having the form of a vertebral centrum, and which correspond in every respect with the neural arch of the vertebra, and shall be termed the occipital arches (Plate II, Figs. 4, 5, and 6, *Oc.* I and *Oc.* II).[22]

The anterior occipital arch is formed by two triangular osseous platelets, meeting together over the spinal cord, above which a non-paired oblong bone, directed upwards and backwards, is fastened by ligaments.[23]

The posterior arch is similarly fashioned, only both of its parts are of an oblong quadrangular shape, and develop on their posterior aspect a small articular facet for the arch of the first vertebra. Upon this arch is found also a pointed bone, directed upwards and backwards.[24]

The pointed bones resting upon the occipital arch are to be considered as spinal processes. At the same time, however, I will remark that inasmuch as they are situated in a line with the uppermost interspinous bones, which, indeed, no longer support the fins, one can just as well count them in with the latter. The boundaries between the fin-rays and the interspinous bones in *Amia* are not strictly defined, and the arrangement or condition they present us with in this form furnishes another proof that these formations originally had a genetic connection with each other. A good drawing of these conditions has been furnished us by Franque in Fig. 2 of his familiar treatise.

The occipital arches of Amia are not of uncommon occurrence, but are generally present either as independent arches, or reduced in various ways, or at-

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[22] Reads *obg.* in original text.—TRANS.

[23] So I find the condition in the older specimens. In the younger individuals, from which the illustration is taken, each half of the occipital arch consists of three separate osseous portions—one lower triangular piece, and two upper ones resting upon it and situated behind one another. It is not possible to find an explanation for this state of things at present.

[24] In the older specimens of *Amia* the two pointed bones are blended into one osseous plate.

tached to the hinder extremity of the skull, as in the higher fishes which are provided with ossified skulls.

In *Polypterus* a free occipital arch has been described by Traquair. Franque has also observed the occipital arches of *Amia*, as would appear from his brief and not entirely lucid description, but their significance appears to have entirely escaped him. Bridge mentions them also. Here and there other authors have noticed them, without having, up to the present time, placed any weight upon the occurrence of precisely the same thing in bony fishes. I have been able also to convince myself that the occipital arch is not wanting in *Leptidosteus*. In this Sauroid I find both halves synosteologically joined together, as well as with the basioccipital, so that this latter bone appears to form by itself the periphery of the occipital foramen. Among the osseous fishes one finds in the pike free occipital arches beautifully developed, also in the Salmonidæ and Clupeidæ; but, as shall now be particularly mentioned, proof can be furnished that all Teleostei originally possessed occipital arches.

Over the occipitale laterale, and connected with it at one small point, is found the conical exoccipital (Plate I, Fig. 1, *Ex.*). It constitutes the boundary to the entrance of the temporal fossa, mesiad, and is partly covered on its superior surface by the posterior margin of the parietal.

The posterior lateral angle of the primoidal cranium is occupied by a thoroughly developed bone, which I, in concurrence with Bridge, can only take to be the intercalare (opisthotic) (Plate I, Figs. 1, 2, and 3, *Jc.*). It is also a conical bone, which is covered above by the posterior lateral angle of the squamosum, and which helps to form the lateral boundary of the entrance to the temporal fossa. It does not articulate with the exoccipital, but remains separated from it by a strip of cartilage lying at the base of the temporal fossa. Posteriorly and beneath it comes in contact with the occipitale laterale, and in some individuals also with the basioccipital. Below and anteriorly, the intercalare, though a very delicate process, meets and unites with a process from the petrosal. To the apex of this bone, chiefly projecting posteriorly, the inferior limb of the supraclavicular is attached, as already shown, by means of firm ligaments. Below, the intercalare meets with the cartilage of the primoidal cranium, at which point something of a protuberance is developed.

It is known that in most osseous fishes the intercalare is wanting, and in the minority, where it still exists, it is feebly developed, with the exception of the family Gadidæ.[25]

Yet a comparison of the condition in *Amia* with that of the *Gadidæ* leaves not a shadow of a doubt that the bone just described is really the intercalare, inasmuch as this very bone in the Gadidæ possesses

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[25] Compare the careful description of the intercalare of the Gadidæ by Vrolick, "*Studien über die Verknöcherung und die Knochen des Schädels der Teleostei.*" *Niederländ. Archiv. f. Zoologie*, Bd. I, 1873.

precisely the same topographical relations to neighboring ossifications of the skull, to the suprascapula, and to the foramen for the exit of the vagus and the glossopharyngeal.

The nerve situated most anteriorly in the occipital region is the glossopharyngeal. Its foramen of exit is found where the intercalare, the petrosal, and the cartilaginous portion of the primoidal cranium come together, and below and between the basioccipital and petrosal (Plate I, Figs. 2 and 3, *gph.*). Immediately after its exit from the foramen the glossopharyngeal divides into its two well-known branches, the distribution of which is of no interest in the present connection.

Thoroughly separated from the glossopharyngeal foramen we find the foramen for the vagus is so located in the suture between the intercalare and the occipitale laterale that its periphery is formed by these two bones (Plate I, Figs. 2 and 3, *v.*[26]). The nerve itself exhibits essentially the same behavior after its exit as in the *Teleostei.*

While yet within the brain-case the vagus gives off a very minute branch, which, ascending upwards, perforates the cartilaginous skull-cover beneath the parietal, into which it enters, probably to supply its mucus canal. I should not have mentioned this little branch at all if the so-called *ramus lateralis nervi trigemini*, which is known to receive fibers from the trigeminus and from the vagus, did not quit the cranium at the same locality in many of the Teleostei. That this nerve in *Amia* also receives fibers through its anastomosis with cranial nerves that arise more anteriorly I have once been able to confirm, but, in consequence of the indifferent manner in which the specimen I examined had been preserved, it was impossible to ascertain from which nerve this anastomosis proceeded. While the occipital region of the Selachians[27] arrives at its posterior limits with the vagus, in fishes provided with ossified skulls several nerves of the occipital group, and of a character identical with the spinal nerves, are constantly to be found between the vagus and the first spinal nerve.

Amia, possessing the largest number hitherto observed of occipital nerves, furnishes us with three such for our consideration. The most anterior of these leaves the brain-case at a minute foramen in the occipitale laterale, and situated near its posterior border (Plate II, Fig. 4, *oc* I). It is of a smaller caliber than the two following, and also differs from them in that it only arises from the spinal cord by means of an anterior root. The nerve next in order arises by both an anterior and posterior root, between the hinder border of the occipitale laterale and the anterior occipital arch (Plate II, Fig. 5, *oc* II). Immediately after their exit these two roots unite in a common trunk, and in so doing carry out the character of a spinal nerve (Plate II, Fig. 5, *oc* III). The first spinal nerve in *Amia* quits the neural canal between the posterior occi-

[26] Marked *vg.* in original text.—TRANS.

[27] As a matter of course only such Selachians are here taken into consideration whose crania are sharply defined from the vertebral column.

pital arch and the neural arch of the first vertebra, presenting us with nothing of particular note.

The three occipital nerves, together forming a group, run downwards in front of the shoulder-girdle, to finally ramify, and—probably together with the branch of the first spinal nerve, agreeing in this respect with the corresponding nerves in the Teleostei—to supply the muscles lying between the shoulder-girdle and the mandible. This I could not establish with certainty, for the reason that the specimen used by me for the examination of the nerves had already served for a dissection of the heart and great vessels. To complete the subject, a canal must yet be mentioned, the function of which I have been absolutely unable to discover. It commences on the lateral aspect of the bassioccipital, and on that portion of this bone which so much resembles a vertebra; it takes a course towards the median plane, turns at a right angle, and terminates at the inferior surface of the bone, between the posterior wings of the parasphenoid. This terminal opening is in close juxtaposition with the same opening of the canal of the opposite side, but no communication exists between them nor with the cavum cranii. The contents of this canal I found to be fibrous connective tissue and thin-walled vessels of some caliber (Plate I, Figs. 2 and 3, *cb.*).

The fact that free and independent neural arches are found upon the basioccipital, from between which emerge nerves of a structure like true spinal nerves, is of fundamental importance in the determination of skulls of the higher fishes, and admits of no other explanation than that which applies to the primoidal cranium, the best example of which we find in the Selachians, where we observe anchylosed together a still greater number of vertebræ, with the nerves that pertain to them making their proper exits.

A question still more difficult of determination is to define the number of vertebræ that enter into the composition of the cranium. In *Amia*, which for this purpose—of all the fishes with osseous skulls examined by me—possesses the best example of this primitive condition, I believe I am enabled to recognize the elements of three vertebræ. That the two occipital arches, with the nerves that pertain to them, represent the remains of what were originally distinct vertebræ, no reasonable doubt can exist; and the only question is whether we are to consider the first occipital nerve, which is very feebly developed and without a posterior [dorsal] root, as a rudimentary spinal nerve, or whether another interpretation is admissible.

If the first occipital nerve is not to be considered as a rudimentary spinal nerve, one can see in it—since it is absolutely inconceivable to have a generation of new nerves in the higher animals—but a branch of one of the two neighboring nerves, namely, of the vagus or of the second occipital nerve, that has branched and become independent. Now, the distribution of the first occipital nerve is such, that one cannot for an instant take it to be a branch of the vagus at all, and therefore the only possibility remains that it could belong to the second occipital

nerve. Such a thing as the branches of nerves eventually becoming new and independent nerves does occur in fishes, and I would invite attention to the condition seen in the spinal nerves in the Gadidæ,[28] and to the condition seen in the *ramus palatinus nervi facialis* in many bony fishes. There are two factors to be taken into consideration that enter into such a divisional process. The first of these is that distal regions supplied by the nerve may grow apart, and become further and further separated from each other; and the second is, that the tendency of each nerve is to take a direct course to the part it supplies. Both of these conditions would eventually bring about a division of a nerve to its very origin. Therefore this division must begin at the distal end of the nerve, and, gradually progressing, must extend finally to the point of origin in the central nervous system.

Precisely the opposite condition is found in the first occipital nerve; distally it is united with the second occipital nerve, it being but partially separated from it. Therefore the only justifiable conclusion we have left us to adopt is that this nerve must be considered as a discrete spinal nerve, the survivor of a retrogressive process, and so in *Amia* we must assume that at least three vertebræ have merged into the cranium.

I have yet to invite more careful attention to a condition not remarked upon by me before. Upon closer scrutiny of the occipitale laterale one sees that the hindermost part of this bone, where it meets the anterior occipital arch, is thickened and consequently well defined from the other bones. The anterior border of this thickened strip is in immediate relation with the minute foramen of exit of the first occipital nerve, and consequently this thickened portion of the bone exactly corresponds in form as well as in its site to a third anterior semi-occipital arch that has merged into the occipitalia lateralia. Now that the proof has been furnished that vertebræ, originally separate, have blended with the skull, an explanation can be given for certain points for examination that are to be found upon the inferior aspect of the basioccipital, which have not been alluded to by me before, because their significance would not have been understood.

Between the two posterior limbs of the parasphenoid, immediately behind the two lower exits of the vascular canals described above, that pass through the basioccipital, one finds two small pieces of cartilage, quite superficially placed upon the surface of the bone. (Plate I, Fig. 2, *x*.) On viewing the vertebral column of this fish from beneath, one can satisfy himself that very similar pieces of cartilage are upon each vertebral centrum; indeed, in younger individuals these cartilages penetrate deeply into the substance of the centra, while in the older specimens only very thin cartilaginous pieces can be recognized resting superficially on the vertebræ.

[28] Stannius, *Das peripherische Nervensystem der Fische*, pag. 119.

Without going any further into an explanation of these cartilaginous formations, which could only be done by a careful comparison of the vertebral column of *Amia* with that of other fishes, I feel called upon to invite attention to the remarkable—even in details—similarity of the posterior portion of the basioccipital to the centrum of a vertebra.

To make a comprehensive statement, the occiput of *Amia calva* reveals the elements of three vertebræ, which are co-ossified with it, and whose individual independence becomes less and less marked from behind forwards. The centrum of the hindmost vertebra, as well as the centra of the other two, is co-ossified with the basioccipital; it is, however, only in the posterior portion of this bone that the evident likeness to the centrum of a vertebra can be recognized. The neural arch of this vertebra cannot be distinguished from the neural arch of a trunk-vertebra, and it possesses also a well-formed spinous process; the corresponding nerve is stamped with all the characteristics of a typical spinal nerve. The middle vertebra, absorbed as it is by the cranium, is quite similarly formed, only that its neural arch has become broader and intimately blended with the cranium. The transformation and co-ossification of the anterior vertebra is the most complete. Both halves of its neural arch are blended with the occipitalis lateralia, and the nerve corresponding to it arises simply as a feeble anterior root [ventral]. This rudimentary nerve is really the only safe indication of the existence of this anterior vertebra, which has in other respects been completely appropriated by the skull; and should one imagine that this nerve was formed through a retrogressive process, or became blended with the occipital nerve, then nothing would remain to give us the slightest hint as to the original existence of this anterior vertebra. This is of importance in so far as it gives rise to the possibility that beyond this vertebra, the existence of which is still to be seen through its last faint traces, there existed other ones, which, however, have become thoroughly appropriated by the cranium so as not to be any longer distinguishable.

The number which I have indicated, then—that of three vertebræ co-ossified with the skull—can therefore only be the fewest of these segments to be recognized. The view that the original number of these vertebræ was greater is by no means to be precluded.

It is hardly worth while mentioning that the facts just discussed by me have nothing whatever to do with the question of the composition of the primoidal cranium out of like constituents—the so-called vertebral theory of the skull. The formation of the primoidal cranium in the Selachii—and maybe, too, in the Cyclostomata—has already been perfectly defined; and setting the question entirely aside as to whether any or how many metameres were contained in those skulls, my only aim was to establish that between the Selachian skull and that of the higher fishes no complete homology exists. The cranium of the higher fishes corresponds to the cranium of the Selachii, plus several (at least three) of the anterior vertebræ of the column.

I would also expressly state that the proof just given only applies to the higher fishes, and that every attempt to assume the same condition for the higher organized vertebrate animals also must be premature at least. I would not have mentioned this particularly if attempts had not been made recently to show that the atlas of the Amniota is co-ossified with the cranium in Amphibia.

Stöhr[29] first made the interesting discovery that the so-called odontoid process of the Amphibia is nothing more than the notochord becoming cartilaginous, and subsequently developing as an ossified process from the first vertebra. Upon this discovery[30] Wiederscheim has made the assertion, for which there is no foundation, that the atlas of the Amniota is to be looked for in the occipital part of the skull of the Amphibia, and that in consequence of this the first vertebra in these forms corresponds to the axis.

After considering that the arrangement of the nerves in the occipital region, and of the first spinal nerves in the Selachians and Amphibia, at least in the Urodela, is identical; that in both, the vagus is the last nerve given off by the brain; further, that the entire occipital region in the Amphibia appears extraordinarily rudimentary, weighty reasons arose in my mind discrediting the idea that we find in the Amphibia the skull appropriating one of the vertebra, and I rather believed that a complete homology of the skulls in the Amphibia and Selachians must be accepted. Wiederscheim's view has its origin in the one-sided comparison of the conditions of organization in the Amphibia with that in the Amniota. Existing Amphibia, so far as their crania go, form a very restricted group by themselves, their structure permitting certain comparisons to be made down the scale toward the Dipnoi and Selachians, but not upward toward the Amniota. Consequently, if one foregoes a direct comparison of the skull of the Amphibia with that of the Amniota, a phylogenetic interpretation of the ontogenetic facts discovered by Stöhr would not be difficult. In all fishes, particularly the Selachians, a conically-pointed piece of the chorda extends into the occipital region of the skull, and one need only imagine that this notochord be transformed to cartilage, and afterwards—developed from the first vertebra—to ossify, in order to arrive at exactly the same conditions as they exist in Amphibia.

Then, to be sure, the odontoid process of the Amphibia is not homologous with the structure bearing the same name in the Amniota, but only presents an analogous formation; yet the supposition of homology even does not seem to me at all probable, inasmuch as it can be easily shown

[29] Ph. Stöhr, History of the Development of the Skulls of Urodela. *Zeitschrift f. wiss. Zoolog.*, Bd. 33. 1880.

[30] Wiederscheim, Comparative Anatomy of the Vertebrate Animals, page 60. It is not uninteresting that Albrecht (*Zoolog. Anzeiger*, 1880, Nos. 64 and 65), upon this same report, draws the opposite conclusion, and interprets the first vertebra of the Amphibia as his imaginary "pro-atlas" lying beyond the atlas, and the odontoid process of the Amphibia as the basioccipital separated from the cranium.

that the formation of the odontoid process out of the body of the atlas in the Amniota only begins among the reptiles.[31] In higher fishes it is very generally found that the anterior aspect of the first vertebra is not excavated, but slightly convex. Now, though it seems to me to be improbable that the conditions in Amphibia can be traced directly to these structures in fishes, yet here is a state of things that can be considered parallel with that of the Amphibia.

An explanation for the singular fact that in the higher fishes independent vertebra are co-ossified with the occiput is not difficult to find, and I believe the reason for this condition is to be found in the way and method in which the parasphenoid makes its appearance.

It has been fully and conclusively shown by Hertwig that teeth can be discovered upon all the bones of the buccal cavity, which arise from these osseous plates through sockets in their substance, and that the parasphenoid forms no exception to this rule, although teeth are found upon it far more seldom than on the other bones of the mouth. If we now know that the appearance of teeth in the Selachians is not confined to the cavity of the mouth, but that they also extend upon the mucous membrane of the fore-gut, as far as the gill slits, thus reaching far below the anterior extremity of the vertebral column, then the supposition will not be startling that the parasphenoid originally did not confine itself to the basis cranii, but extended far behind it upon the vertebral column.

In fact, we meet with the parasphenoid occupying this very position in those fishes in which bone first begins to appear, in the cartilaginous Ganoids, and in the Dipnoi. As already known, the parasphenoid of Stöhrs does not confine itself to the base of the true skull, but extends backwards to be applied to the inferior surface of the centra of about 7 or 8 vertebræ. According to Wiederscheim this is the arrangement in *Polypterus*, and Günther tells us that it also occurs in *Ceratodus*, only in these fishes the number of vertebræ covered by the parasphenoid is fewer. This also must have been the state of things in the direct ancestry of the existing bony Ganoids and Teleostei. Now, after the parasphenoid had ceased to be a tooth-bearing bone of the cavity of the mouth, a curtailment from behind took place, and at the same time a reduction in number and consolidation of the vertebræ resting upon this bone, which was already firmly connected with the cranium, set in, to replace the latter, a transformation the last traces of which can still be seen in bony Ganoids and Teleosteans.

The region of the labyrinth[32] is bounded posteriorly by the foramen

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[31] Gegenbaur, *Grundzüge der vergl. Anatomie,* 2 Aufl., page 615.

[32] Labyrinth region, the term here used, applies more particularly to that space as seen in the Teleostei and bony Ganoids, which, by the way, it does not entirely include, as the labyrinth in these fishes generally extends beyond the confines given; moreover, all the bones enumerated by me as belonging to the occipital region may, under certain circumstances, serve for the inclosure of parts of this area. So I have retained the term simply to avoid a new name.

for the exit of the glossopharyngeus; anteriorly by the postorbital process and the posterior circumference of the orbit.

It forms the greater part of the lateral wall of the skull situated behind the orbits and includes the ossified petrosal and postfrontal.

The *petrosal* (Plate I, Figs. 2 and 3, *Pe*) is nearly circular in form, being connected behind and above by a small part of its periphery to the intercalare in a serrate suture.

It is separated from the surrounding bones by broad areas of cartilage, from the basioccipital posteriorly, the squamosal laterally and above, the postfrontal above and anteriorly, from the alisphenoid anteriorly, and from the petrosal of the opposite side by a mesial band of the same material.

Above the petrosal we find the long, flat, and longitudinally placed facet of articulation for the hyomandibular (Plate I, Figs. 2 and 3 *hm.*). This facet is entirely in cartilage, with the exception of the postero-superior angle, which is slightly overlapped by a thin piece of the squamosal.

Anteriorly and above the petrosal lies the ossified postorbital process—the *postfrontal* (Plate I, Figs. 2 and 3, *Psf.*). This bone has the form of a triangular pyramid, whose apex is directed laterally and upward. The superior aspect of this bone, which is stamped with all the characters of a dermal bone, has already been thoroughly described; of the two remaining sides, one faces outward and the other assists in forming the hinder part of the upper margin of the orbit. The ossification of the postfrontal does not reach through the entire thickness of the lateral cartilaginous skull wall, but remains separated from the brain cavity at all points by cartilage. Now, at the dividing line between the bone and the cartilage there lies a canal that commences at the lower margin of the bone at the side of the skull and makes its exit at the anterior angle of the temporal fossa. So far as I could satisfy myself, it contains vessels intended for the soft parts contained in the temporal fossa. This canal has no greater morphological significance, and I only mention it for the sake of making my description complete. Two openings are formed near the anterior margin of the petrosal; the upper and larger one is for the facial nerve and jugular vein (Plate I, Figs. 2 and 3 *fa.*), the smaller and lower one for the carotid (Plate I, Fig. 3 *ca.*). While still in the brain case the facial nerve gives off a branch which, running forward, enters the orbit at the posterior margin of the fenestra—to be spoken of further on—thence traversing the lower lateral margin of this cavity, to be distributed to the mucous membrane of the mouth.

This branch of the facial, which universally occurs in the Teleosteans, has always been referred to as the homologue of the *ramus palatinus* of the Selachians. If one considers that the *ramus palatinus* of the Selachians always arises extracranial from the facial, and from this origin runs anteriorly, while the nerve bearing the same name in *Amia* and bony fishes has an intracranial origin, the question of their homology

becomes dubious. To render this homological comparison safe, we must have the positive proof, now missing, that this branch penetrates from the outer side of the skull to the inner in this series of fishes. The further distribution of the facial nerve after it quits the brain case is of no further interest in the present connection.

The orbital region is very definitely marked off. Its posterior boundary has already been alluded to; anteriorly the antorbital process, with its ossification, the prefrontal, divides it from the nasal region. In *Amia* the orbits are tolerably flat and oval depressions, separated from one another in the median plane by an antero-projecting process of the cavum cranii (Figs. 9 and 10); there is not a trace present in *Amia* of a bony or membranous interorbital septum, as we find in so many of the Teleostei.

The roof of the orbit is formed only to a limited extent by a cartilaginous, laterally-projecting ledge of the primoidal cranium, which one may consider as the last remnant of a cartilaginous orbital roof (Figs. 2 and 3), the greater part of this roof being furnished by the frontal bone. An orbital base is indicated by a feebly developed, winglike ledge projecting from the basis cranii, which is in contact with the parasphenoid beneath (Figs. 9 and 10).

The anterior third of the wall of the orbit is entirely cartilaginous,[33] while the posterior two-thirds are in part occupied by two ossifications. There is a large foramen found in the posterior part of the orbit, bounded above, behind, and in front by serrate edges of bone and below by cartilage, which opens into the brain case (Plate I, Figs. 2 and 3, *Op.*).

Posteriorly through this opening passes the optic and several other nerves out of the cranium, and through it the muscles of the eye reach the skull; anteriorly it is closed by a strong fibrous membrane. In many of the skulls of the Selachians one can see a fenestration of the lateral wall of the cranium, which is an extension of the foramen opticus, and it does not appear very improbable to me that the foramen I have just described in *Amia* is to be regarded as such a foramen opticus, much enlarged. At the boundary line between the labyrinth and orbital regions the cartilaginous base of the cranium is further pierced by a small foramen, which is covered by the parasphenoid, and which is only disclosed by removing that bone (Plate I, Fig. 3, *fh.*). This foramen in its position corresponds to the hypoplysis—to be described further on—and is to be compared in many bony fishes to that lengthened cleft at the base of the fossa for the muscles of the eye, which is closed by the parasphenoid.

The *alisphenoid*, constituting as it does the posterior ossification of the orbital region, is of a circular form, with a section cut from it below

[33] In a large specimen of *Amia* I saw the lateral, as well as the side toward the median plane—facing towards the cavum cranii—of this anterior orbital cartilage covered by a thin superficial layer of a brownish color, which at first sight looked like a very thin lamella of bone. A microscopical examination showed here that we had to deal with a calcification of the superficial layer of cartilage.

and anteriorly. This missing section is the foramen just described, and its outline depends upon it (Plate I, Figs. 2 and 3, *As.*).

Near its posterior margin the alisphenoid is perforated by a large circular foramen, intended for the second and third branch of the trigeminal. In large specimens of *Amia* the alisphenoid articulates above and posteriorly with the postfrontal; in younger individuals it is separated from the latter by a small zone of cartilage. Above the optic foramen, anteriorly, it is to a small extent suturally united with the orbitosphenoid.

Beyond the alisphenoid is found the *orbitosphenoid*, circular in outline and pierced behind and below for the optic foramen, of which nothing further will be remarked (Plate I, Figs. 2 and 3, *Os.*). It seems to me that at this point it would not be uninteresting to call attention to the circular form of so many of the ossifications of the primoidal cranium of *Amia*.

These forms are due to the fact that the centers of ossification start free in the cartilaginous matrix, and in their unhindered growth, which has been a proportionate increase of margin in all directions, they have but at a few places only been checked by contact with neighboring ossifications. In this respect, too, *Amia* has been preserved in a primitive condition, as compared with the Teleostei, in which the corresponding bones, owing to the fact of their contact at most points with their neighbors, exhibit a great irregularity of form.

The first branch of the trigeminus passes through the wall of the primoidal cranium at about the height of the anterior margin of the postfrontal, runs obliquely forwards and outwards, and quits the alisphenoid just above the large foramen for the second and third branch of the same nerve (Plate II, Fig. 6, *tr.*[34]).

During its course within the wall of the skull it gives off several minute branches, which ascend upward in the cartilage and pass to the mucus canals of the bones of the skull-cover. In the orbits these branches are two in number, and lie parallel to each other; just beneath the "cover;" they pass forward to reach the nasal depression to which they are distributed, and in doing so pass between the cartilaginous cover of the primoidal cranium and the frontal.

During its entire course through the orbit it gives off minute ascending branches, which in part perforate the cartilaginous roof, described above as the remains of the vault of the orbit, which is composed of this material, while another branch passes to be distributed to the mucus canals of the frontal bone.

The second and third branches of the trigeminus nerve pass from the skull cavity through the foramen in the alisphenoid already referred to, and are distributed in precisely the same manner as they are in the Teleosteans (Plate II, Figs. 4 and 5, *Tr.*).

[34] *Tr.* in the figure.—TRANS.

The oculomotorius and the trochlearis pass out through the large posterior foramen of the orbital region, at its posterior margin, the first-mentioned nerve above and the second beneath it.

Between these two nerves lies the group of straight eye muscles, of which the rectus externus is contained to some degree inside the cranium, and gives rise to the development of an eye-muscle canal.

Just anterior to the eye muscles, yet partly lying between them, we find the optic nerve, which in *Amia* is but feebly developed, owing to the small size of the eye. The ophthalmic artery, quite large in *Amia*, passes also into the bulbus with the optic. Between the last-named structures lies a strong fibrous cord, which arises at the posterior lower angle of the orbital cavity, to be inserted near the place of entrance of the optic on the bulbus. This cord corresponds in every respect to the *eye supports* in the Selachii. The two oblique muscles are inserted into the anterior angle of the orbit.

The nasal region of the primoidal skull of *Amia* is bounded behind by the antorbital processes, and has the shape of a triangular plate, bearing a superior median crest. With the exception of two small ossifications, the entire region is cartilaginous. On the inferior aspect of this region, situated mesially and in front of the antorbital processes, lie two oblong cartilaginous articulating facets for the anterior extremity of the palatine arch; the distal end of these touches the ossified part of this region, the *septomaxillare* (Plate I, Fig. 3, and Plate II, Fig. 5, *Smx.*). This is an osseous center that extends from the lower margin of the foramen for the nasal nerve to the lateral margin of the prenasal cartilage, and with which the maxillary is movably articulated at the latter place. The greater part of this small bone is covered above by the *intermaxillary*, and only becomes visible after this bone is removed. This bone has been declared identical by Bridge with the ossification at the base of the nasal capsule of the frog (the *septomaxillare*); and although I consider the homology thus assumed as at least improbable, still I did not introduce a new name.

It would appear to me more correct if Bridge had compared the two small ossifications known to us, which occur at the extremity of the cartilaginous rostrum of the Pike, with the septomaxillary of *Amia*, with which, indeed, they correspond in position as well as in their relation to the neighboring parts of the skeleton.

The cranial cavity is egg-shaped, with the apex directed forwards; that about the labyrinth region presents two niche-like depressions, for the concealment of the labyrinth, that are sharply defined as we proceed backwards towards the hinder extremity of the brain case. In *Amia*, as among the Selachii and Ganoids, this depression extends from the foramen magnum to the nasal fossæ. Not all of the ossifications of the primoidal cranium that are to be seen on the outer aspect are to be observed on the inner walls of the brain case or in the connecting spaces of the labyrinth; on the contrary, quite a number of them do not reach

through the entire thickness of the skull wall, and therefore remain separated from the cranial cavity by a layer of cartilage.

The exoccipital, the intercalare, and the post- and prefrontal are found to be in this condition.

It is hardly worth while mentioning that the squamosal also belongs to this category, applied as it is, in most fishes, to bound a portion of the outer arch; a like condition obtains in *Amia*, where, as has been fully discussed, it retains the character of a cover-bone throughout life.

Within the cavum cranii the anterior part of the occipital region is very sharply defined by an elevation directed anteriorly and towards the median line, composed partly of cartilage and partly of membrane, which runs along the lateral wall from above downwards, forming the posterior wall of the niche of the labyrinth. The base of this region is formed by the basioccipital, by the lateral walls, and for the greater part also by the cover-bone of the occipitalia lateralia; the adjoining portion of the spinal canal, which is covered by the occipital arch posteriorly, does not lie in the same plane with the base of the brain cavity, but is found higher up on the posterior wall of the skull, so there remains a fossa in this locality, which terminates blindly behind and below, over which the medulla oblongata and the anterior end of the spinal marrow pass. This depression is filled in with the now recognized interdural lymphatic fat tissue, [35] most extensively found in the Teleosteans, and becomes interesting to us for the reason that in the family of Characinides, Cyprinoides, the Shads and Gymnotides, it is this very depression that is partitioned off from the rest of the skull cavity by the crests of the occipitalia lateralia, which meet mesially, and is utilized for the formation of the "atrium sinus imparis," which is connected with the swim-bladder by means of the apparatus of Weber. The broad foramen for the vagus is situated at the anterior margin of the occipitale laterale. The anterior border of the labyrinth region within the brain case is formed by the anterior margin of the petrosal which does not join with the anterior bounding ledge of the labyrinth niche, but runs a little before it. The exceedingly complicated structure of the labyrinth niche, with the canals for the arches, is for the most part cartilaginous; its lateral wall is only formed by the petrosal below and anteriorly. The labyrinth is divided by a medial and projecting cartilaginous elevation, running anteroposteriorly and from above downwards into two fossæ, the smaller one being situated anteriorly and above, the larger one posteriorly and below; the former contains the greater part of the utriculus, the latter is intended for the sacculus with the recessus cochlearis. The recess for the sacculus forms, as I have already had occasion to state, quite a prominence on the lateral wall of the skull, which is to be regarded as the commencement

[35] Usually this fat tissue of fishes is taken for the arachnoid in these forms. I have reserved my full reason for a dissenting view for a later work.

of the *bulla acustica*, so extensively and in some cases excessively[36] developed in the Teleostei. I wish to state once more particularly that the canals intended for the arches, and bounded everywhere by cartilage, join with the labyrinth niche.

The anterior semicircular canal begins at the anterior upper portion of the utriculus inlet, courses laterally forwards and upwards, makes a turn in the vicinity of the postfrontal, running close beneath the cartilaginous skull cover, to be partly seen through it posteriorly and towards the median line, and finally terminates in the cavum cranii in an opening above the vestibule of the labyrinth (labyrinth niche). The outer semicircular canal takes its origin from the posterior portion of the utriculus, courses laterally and backwards, is barely seen just beneath the hyomandibular facet through the cartilaginous side wall of the skull, then proceeds backwards towards the median plane to find its exit, in common with the origin of the posterior canal, on the hinder boundary of the sacculus. During its course the outer canal approaches tolerably close to the intercalare. The posterior semicircular canal begins, as already stated, at the posterior margin of the sacculus, courses laterally backwards and upwards, comes almost in immediate contact with the exoccipital, then turns towards the median plane, forward, and makes its exit just above the vestibule of the labyrinth.

The description of the membranous labyrinth can be briefly presented. So far as I could convince myself from the specimens that were at my command, and really which were hardly suitable for a critical examination, it perfectly corresponds in its general structure with the labyrinth of the Teleostei, as we have learned from the admirable investigations made by Hasse.[37] It is described still more in detail by Retzius.[38]

The relation of the labyrinth to the cavum cranii in *Amia calva* shows a marked difference when compared with that of the Selachii. While in the Selachians the cavity of the labyrinth seems entirely isolated from the brain case, there exists in *Amia* and all other Ganoids and Teleosteans a more or less broad communication between these cavities. It would hardly be amiss if one would trace the causes of the varying size of the intercommunicating fenestra between the two cavities to the entirely disproportionate development and unfolding of the body of the labyrinth in the higher fishes, which has finally led to a stinted growth of the medial dividing wall of the same. The acusticus foramen has been in all probability the starting point for the fenestration of this wall. At least I think we are justified in assuming this from the position of this foramen of the labyrinth in *Amia* (when it is nothing more than the occurrence of absorption of the periphery of the foramen acus-

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[36] In the *Scopelus* and *Gonostoma* I find a very extraordinary development of the bullæ acusticæ.

[37] C. Hasse, *Anatomische Studien*, Th. X. *Das Gehörorgan der Fische.* Leipzig, 1873.

[38] G. Retzius, *Das Gehörorgan der Wirbelthiere* [Vertebrates]. Th. 1. *Fische und Amphibien*, page 35. Stockholm, 1881.

ticus) as well as the fact that fenestrations in the skeleton in general are predisposed to proceed from the peripheries of the nerve foramina; as examples of which I would invite attention to the various foraminal perforations that occur at the points of exit of the cranial nerves in Selachians.

It is my wish now to make especial mention of certain important differences that exist between the labyrinth in *Amia* and that cavity in the Teleosteans. The more complete development of the labyrinth in osseous fishes has finally led to the belief that the still distinctly marked elevations that bound the labyrinth niches in *Amia*, where they occur in a rudimentary condition or are altogether absent, have resulted in a mergence of the cavity of the vestibule into the general cavity of the brain case, and that the labyrinth has really moved further backwards from its original position, appropriating parts that belonged to the occipital region, for its concealment. Besides, in the Teleostei the anterior arch has through a reduction in size of the broad cartilaginous strips, which in *Amia* separates it from the skull cavity, very frequently come to lie in the latter.

Finally, an important difference is seen in the fact that the almost entirely cartilaginous border of the labyrinth has in the Teleosteans been replaced for the greater part by a bony one. Underneath and behind the foramen for the facial, the petrosal throws off a horizontal lamella of bone, which in the middle line joins with the corresponding lamella of the opposite side, and forms the roof of a part of the cavum cranii that is closed posteriorly. It is the hindmost of the osseous part of the recess for the eye muscles, which is largely membranous in *Amia*, and of which an accurate description will be given further on.

While the limits of the separate regions of the skull are but feebly defined upon the skull-cover, quite a sharp definition takes place between the labyrinth and the orbital regions in the interior of the skull on its cover; this is through the means of a feebly-marked ledge, extending from one postorbital process to the other, and directed downwards towards the cavum cranii; here its lower edge meets the ascending epiphysis coming from below. This epiphyseal ledge of the skull-cover is constantly found in all Teleosteans, and represents in some individual cases the only remaining portion of the original cover of the primoidal skull.

The question which considers the channels through which the sound-waves of the surrounding medium reach the labyrinth in fishes has never, up to the present, been the subject of an exhaustive discussion. And yet the question deserves to be investigated, because quite a number of peculiar formations upon the skulls of fishes will become intelligible only after we have become acquainted with the nature of the sound-conducting channels. It does not demand any particular mention—inasmuch as an experiment is naturally out of the question—that the solution of this matter can only be brought about by critical

investigations of the topographical relations of the labyrinth region in the skulls of fishes, and the determination of the sound-conducting channels according to purely physical principles. The prevailing idea at present is that, in fishes generally, no special channels for the conduction of sounds have been differentiated; that, on the contrary, an entirely evenly-proportioned conduction takes place through the bones of the skull, and above all through its cover-bones. Specialized auxiliary apparatus of the ear, intended for the conduction of the sound-waves to the labyrinth, with the least possible loss, are said to appear first in the class Amphibia; this is positively erroneous. A superficial review of the majority of fishes demonstrates the improbability of this assumption. In the vast majority of fishes the bones of the cranium at no place enter into contact with the surrounding medium, but are separated from it by extraordinarily poor sound-conductors, by a thick swardy skin, and frequently even by powerful layers of muscles, so that the conduction of the sound-waves directly through the bones of the head can be counted on in a comparatively very small number of fishes only, as in those whose heads are covered by naked bone-shields. The possibility that it takes place through a general conduction on the part of the bones must be absolutely set aside for the vast majority of fishes, and we will have to look about us for other channels of conduction.

Such a channel has been found for us by Hasse[39] in the Clupeidæ. He found that that portion of the auditory capsule, which bounds the sacculus laterally, forms the inner wall of the gill cavity, and so enables the sound-waves to infringe upon the sacculus through this space. These observations are correct, only that Hasse has erred in that he regards the intimate relations of the labyrinth to the gill cavity as confined to the Clupeidæ, whereas it occurs in the majority of osseous fishes. In a large number of these latter, representatives of the most widely separated families, I found almost without exception that the anterior superior apical recess of the gill cavity lies in close juxtaposition with the labyrinth region of the skull, consequently at this point the water present in the gill cavity is only separated from the thin, lateral osseous or cartilaginous wall of the labyrinth by a thin mucous membrane. In numerous cases, in which the sacculus with its otoliths is fully developed and forms a lateral jutting bulla on the skull, this bulla almost without exception projects into the gill cavity, and in many instances can be felt from the gill cavity by the finger with great ease. Yet I would have it distinctly understood that in most cases it is not the sacculus alone that has this relation to the gill cavity, but that the utriculus also enjoys a similar relation, and so it is not admissible here to

[39] C. Hasse, *Anatomische Studien; Suppl. Die vergleichende Morphologie des häutigen Gehörgangs der Wirbelthiere*, 1873, page 53. [C. Hasse, Anatomical Studies; Suppl. The comparative morphology of the membranous auditory passage of the vertebrated animals, 1873, page 53.]

assume, as Hasse did, that we are dealing with a sound-conducting channel or medium specially intended for the sacculus. At present I cannot yet enter upon the details of the relations of the labyrinth to the gill cavity in the Teleostei, to which I must refer to special descriptions to be published later, upon the crania of separate families of osseous fishes.

Now that the grounds for the assumption have been demonstrated, that in bony fishes the sound-waves for the most part reach the labyrinth from the gill cavity, the remaining question presents itself as to how the sound-waves get into the gill cavity. There can be no doubt that the gill cleft plays an important part here; still I believe I am able to point out yet another channel which, according to physical principles, must be even better suited for the purpose. I mean the conduit which is presented in the bones of the opercular apparatus, especially by the operculum and sub-operculum. If one reflects that these bones are thin elastic plates in most Teleosteans, which through their broad surface are in contact with the water contained in the gill cavity, and covered as they are by a thin skin only, and at no time being covered by large masses of soft parts; then one must admit that an apparatus, thoroughly suited to the purpose, here presents itself for the conduction of the sound-waves from the outer medium to the body of water in the gill cavity. Should further investigations confirm this supposition, it would establish the statement formerly made by Geoffroy St. Hilaire who, as we are aware, declared that the opercular bones were ossicula auditus; to be sure in an entirely different sense from what this author meant. Although somewhat foreign to the subject of my paper, a comparison of the sound-conducting media of the bony fishes with those parts in other vertebrated animals, especially the Selachii, is of great interest, because such comparisons very well illustrate the position that the Teleosteans hold with respect to other vertebrates.

The common opinion is, that differentiated sound-conducting apparatuses first made their appearances in the Amphibia, more particularly among the Anura. It has already been sufficiently dwelt upon that this view is an erroneous one, and that in the majority of bony fishes no *general* conduction of the sound-waves to the labyrinth takes place; that, on the contrary, channels have been differentiated of a constant character. But osseous fishes are not the forms—in the vertebrate series—in which such auxiliary apparatuses to the organ of hearing first appear; contrivances for such purposes can already be demonstrated to exist in the Selachians, from which the apparatuses in the bony fishes were derived. The credit belongs to Johannes Müller[40] for being the first to truly recognize and appreciate these conditions in the Selachians;

[40] *Vergleichende Anatomie der Myxinoiden. Theil III. Das Gefässystem der Myxinoiden. Abhandt. d. Berlin. Akademie d. Wissenschaften von Jahre* 1843. [Comparative Anatomy of Myxinoids. Part III. The vascularsystem of the Myxinoids. Treat. of the Berlin Academy of Sciences, 1843.]

unfortunately his observations appear to have entirely passed into oblivion, at least I have not come across a single allusion to them in the writings of the more recent authors. The sound-conducting apparatus in the Selachians is the hyomandibular cleft. This starts, as we know, with a wide opening in the buccal cavity in a position nearer the median plane than the opening of the first gill cleft, and close to it, and then courses upwards between the hyomandibular and the palato-quadratum, making its exit either in an opening, the aforesaid hyomandibular cleft, behind and above the eye, or ending blindly beneath the skin. During its course this canal lies close to the labyrinth region, and in individual cases it even presents special blind diverticles, which adhere closely to it. This is the point in Selachians where the labyrinth is nearest the surrounding medium, and through this channel the sound-waves must reach it the least diminished in intensity. That they may be conducted, too, from the surface of the head, is by no means to be set aside—such general transmission, to a limited extent even taking place in man through parts of the skeleton of the head—yet the idea of such a conduction in the Selachians, if the parts concerned are investigated according to physical principles, must be utterly abandoned, when we come to compare this with the part played as a conductor by the hyomandibular cleft [*speitzloch canal*]. The sound-waves to only a limited degree can enter the hyomandibular cleft from the cavity of the mouth, and will at least in cases where there is a wide, open, external cleft existing, find their entrance through it.

The fact that the hyomandibular cleft of the Selachians being homologous with the tympanic cavity and the canals in the higher vertebrates, and exercising a similar function, is certainly very remarkable. This demonstration effects the removal of one difficulty, and that is the belief that the tympanic cavity and the canals first originated among the air-breathing vertebrates. In fact it was scarcely at all understood how for this purpose, a gill cleft, whose very existence depends upon its being constantly in water, could continue to exercise its true function, and still to some extent be subservient to the organ of hearing. This difficulty is completely set aside by the discovery that the sound-conducting function of the anterior gill cleft is not a new acquisition in land vertebrates, but that it also existed in their ancestors living in the water; and with these the reason [*ursächliche moment*] for this is also furnished, why this gill cleft could still survive, retaining its integrity to the very last and in the most advanced vertebrates in the scale of development, while the other gill clefts, originally provided with respiratorial functions, have disappeared without leaving a trace, having commenced in the Dipnoi and Amphibia with the development of a new respiratory organ.

After what we have just demonstrated, the fact that the Urodela and several of the Anura possess no tympanic cavities or Eustachian tubes, is to be differently construed from what it has been heretofore. Here,

without doubt, a retrogressive process is presented us, as in the snakes; and the alternative proposition, that in these forms a middle ear has not yet developed, is untenable. In fact it would be incomprehensible, if the closed foremost gill cleft of the higher Amphibia were to reopen itself and re-enlist its functions in connection with the auditory apparatus. Equally unintelligible would be the occurrence of the columella in Urodela—a part of the skeleton whose origin is closely associated with the development of the middle ear, and if it existed by itself its need could not be understood, inasmuch as no function for it could be discovered.

The question now remains whether the apparatuses we have just described for the bony fishes and the Selachians originated entirely independently of each other, as appeared at the first glance, or whether there are not organs somewhere in existence which constitute the connecting links between them, and allow a genetic connection of these apparently entirely different formations to be entertained.

A direct comparison of the apparatuses in the Selachians with the Teleosteans leads to an unsafe result, inasmuch as the topographical appearances on the skulls of these forms are entirely different, and as a natural consequence the various relations of the parts cannot be compared with each other in detail; therefore it only remains for us to look about us for the intermediate forms and through them attempt the solution of the question. Such an absolutely intermediate form—of course only for the purpose mentioned—is *Polypterus*. While the cranium of this Sauroid, and particularly its maxillary apparatus and gill apparatus, very closely approach the Teleostean type, the *Polypterus* during life possesses a well-developed hyomandibular cleft, and in this respect reminds us of the Selachians. The inner, capacious opening of this cleft lies in the gill cavity; it is bounded mesially by the epibranchiæ of the first gill arch, posteriorly by the anterior margin of the hyomandibular, and laterally by the bones of the palatal arch. This wide hyomandibular cleft takes an upward direction, lying close to the labyrinth region of the skull, to make its exit at the upper and lateral margin of the cranium in a slit-like opening, that is covered by two small dermal bones, which act like valves. In *Polypterus* the conduction of the sound-waves to the labyrinth can scarcely take place through the outer opening, closed as it is by the small dermal bones just referred to, so we must believe that the sound-waves enter at the inner and least difficult opening, as this does not open into the buccal cavity—as in the Selachians—but into the gill cavity, which is in complete communication with the outer medium.

A comparison of the hyomandibular cleft in *Polypterus* with the blind apical recess lying close to the labyrinth region in bony fishes places it beyond all doubt that they are homologous structures, and that this recess of the gill cavity, which was alluded to when speaking of the Teleosteans, is nothing more than the hyomandibular cleft which has

become widened and closed up at its dorsal aspect. An anatomical reason for this closure, I believe, must be looked for in the development of the hyomandibular in bony fishes. While in the Selachians this part of the skeleton is a slender cartilaginous rod; in osseous fishes it becomes more extensive, in conformity with the greater development and differentiation of the muscular system of the maxillary apparatus, so as to form a broad plate. Correlated with this, we also find the articular facet for this bone in Teleosteans, extending so far as the postorbital process, which extension anteriorily closes the hyomandibular cleft. The relations of the main trunk of the facial nerve—the *truncus hyoides mandibularis*—affords the strongest proof that this extension was in anterior direction, or towards the anterior extremity of the body. In Selachians this nerve passes close to the hyomandibular, coursing downwards in front of its anterior margin, while in the Teleosteans, in the majority of forms, it perforates the hyomandibular bone in order to reach the outer side. It requires no special demonstration to show that such an apparent perforation of the bone could only have been accomplished by its growth forwards, inclosing the nerve as it did so. At the same time the hyomandibular cleft had to be necessarily closed up and transformed into a blind recess in the gill cavity and with the same topographical relations with the labyrinth as we have described for it.

At the base of the orbital region, in the interior of the skull, there is a depression which is well defined both anteriorly and posteriorly, that reminds us to some degree of the sella turcica of the higher vertebrates (Plate II, Fig. 4). Posteriorly, this depression is continued beneath the processes of the petrosal bone, already referred to, where it terminates; anteriorly it is bounded by a bar of cartilage, which contains an osseous center at each lateral angle. At the base of this pit there is a breach in the primoidal cranium, already mentioned, which is closed in below by the parasphenoid. In the direction of the cavum cranii, speaking in a more limited sense, this pit is entirely closed by a strong membrane, which glistens like a tendon. This latter spans the space between the anterior sharp margin of the united and horizontal wings of the *ossa petrosa* to the foremost cartilaginous bar. This membrane extends far up the lateral walls of the skull, and becomes attached about half way up to a sharp bony crest that is developed downwards and mesially from the ali- and orbito sphenoid (Fig. 7, *Kl.*[41]). The posterior part of this upper extension of fascia ensheaths the trigeminal and facial nerves near their points of exit from the skull; the anterior part of this fascia is the membrane that closes the optic foramen.

This fascia divides off another space, situated below and somewhat laterally from the true cavity of the skull, which of course is intended for the brain. The greater part of this space is filled in with the well-known lymphoid fat tissue, found so extensively throughout the fishes, that is also contained in the remaining part of the cavum cranii in

[41] Dr. Sagemehl has failed to place these letters on his figure.—Trans.

Amia; there are also nerves and muscles to be found in it. The facial, with its ramus palatinus, and the trigeminus course through the postero-lateral divisions of this space, as already stated, between the membrane and the bony lateral wall of the skull for some distance before they arrive at their foramina of exit. In the anterior part of this space the membrane is perforated by the opticus.

In the lower part of this cavity, which is separated as we have described from the brain case, are to be found the points of origin of the external rectus muscle. These arise near each other not far from the median line, close behind the cartilaginous transverse bar, already referred to above, that forms the anterior boundary of the sella turcica; anteriorly these muscles diverge from each other, each to enter an orbit through the optic foramen on either side. So we find in *Amia*, as in so many of the bony fishes, a subcranial canal, which to be sure is but feebly defined, lacking as it does a superior osseous partition to divide it from the cranial cavity. The nervus abducens perforates the fascia from above, and immediately passes into the substance of the external rectus muscle, so that it is not visible in the orbit proper. In addition to this, the principal branches of the carotid artery are to be found in this subcranial canal. Upon the membrane above this canal lie the *hypophysis cerebri* and the *lobus vasculosus* in a feebly developed funnel-shaped depression.

We will now turn our attention again to the two ossifications, found in the lateral angles of the anterior cartilaginous bar. These cannot be observed from the outside, and it is only in the dissected skull and after the fascia has been removed, that they are exposed to view. Bridge has called these parial ossifications the basisphenoidea and declares that they are homologous with the well-known Y-shaped basisphenoid of many of the osseous fishes.

This statement I fully indorse. If we bear in mind that besides the *recti externi*, the other muscles of the eye also make their appearance in the cavum cranii, then the cartilaginous partition lying between these two groups of muscles must necessarily be implicated, and the two centers of ossification already spoken of must through extension eventually meet and merge into each other, forming a non-parial bone, situated between the muscles of the right and left bulbus. It is then that we have the conditions presented to us seen in so many of the bony fishes.

If this explanation be not accepted, then we must see in *Amia* certain ossifications that occur in no other fish, and must deny *Amia* a bone of very frequent occurrence.

The next thing before us is to compare the subcranial canal, which lodges the muscles of the eye in *Amia* with that canal as found in osseous fishes, and endeavor to ascertain whether it cannot be traced to a known and similar structure in forms occupying a lower position in the scale. I will first briefly compare it with the canal as found in the Teleostei.

The principal difference between the subcranial canal for the eye muscles in *Amia* and that in bony fishes, is seen in the fact that in the latter it is separated from the brain case proper by an osseous partition, while in *Amia* this is composed only of membrane. In articles I have yet to publish, it is my intention to show how this osseous partition is developed in bony fishes from the neighboring bones, more particularly the petrosal, by their throwing out horizontal processes that meet to ossify in the median line of the skull. Commonly, too, this subcranial canal extends farther back in osseous fishes than it does in *Amia*, even to extend into the basioccipital. This results from the muscles of the eye being longer in these forms, and consequently a canal of proper length developes to accommodate them.

Concerning the phylogenetic origin of the subcranial canal, Gegenbaur conjectures that the *canalis transversus* of the Selachians is the subcranial canal of the Teleostei, in which the muscles of the eye find lodgment.[42] In the Selachians this canal passes from one orbit to the other, obliquely through the cartilaginous basis cranii, causing the two periorbital lymph sinuses to merge into one; in some cases it is separated from the brain case by membrane only. Immediately in front of this *canalis transversus* are found the openings for the carotids, which in some forms are separated from the former also only by membrane. In the orbits the recti muscles are inserted nearest to the anterior entrance of the subcranial canal. Quite close to this we also find—at least in several Selachians (*Hexanchus*)—the foramen of exit for the nervus abducens.

A great deal in the structure of the parts in question, so far as examined in *Amia*, goes to support this view. Above all, the fact must be noted that in *Amia* the canal separated from the cavum cranii is not entirely devoted to the eye muscles, as in the Teleostei, but is largely filled in by the lymphoid tissue.

Now, since we have not the least ground for assuming that *Amia* is descended from forms in which the muscles of the eye were far better developed, and filled the space alluded to entirely, there is but one hypothesis possible, that *Amia* has in this region a preformed lymphatic fossa situated at the basis cranii, into which the points of origin of the *recti externi* only moved secondarily. But this preformed lymphatic space—if we are to judge from homologous structure in inferiorly organized fishes—can only correspond to the *canalis transversus* of the Selachii, which, in *Amia*, is remarkably widened and spread out, and which has finally included the carotid canals and the surrounding nerves found near the exits of these vessels. At the same time its cartilaginous

[42] C. Gegenbaur, *Untersuchungen zur vergl. Anatomie d. Wirbelthiere. Heft III. Das Koffskelet d. Selachier*, 1872, pag. 78. [C. Gegenbaur, Observations upon the Comparative Anatomy of Vertebrates. Part III. The skeleton of the head in Selachii, 1872, p. 78.]

roof was replaced by a membranous one. So long as such organizations exist and no intermediate forms are known to us between the primitive structures seen in the Selachians and the relatively and already widely differentiated organization of *Amia*, this view of Gegenbaur's must remain an hypothesis; an hypothesis, to be sure, that has much to support it. By accepting it, the survival of the transverse canal of the Selachii is accounted for in higher vertebrates, if nothing else, and one is not compelled to advance the dubious proposition that there exists in *Amia*, and in Teleosteans descended from *Amia*, a canal beneath the cavum cranii, unique in the sense of being without antecedents, and whose importance and homology would be quite enigmatical. The olfactory region presents for examination two spacious canals in the interior of the skull, running side by side, parallel and in an antero-posterior direction, which are separated from each other by a broad cartilaginous septum, and which end in the foramina olfactoria at the base of the nasal fossæ. In the canals, which are to be considered as the direct continuation of the cavum cranii, are to be found the very thick and firm olfactory nerves. They are composed of a strong neurilemma which surrounds a fasciculus of nerve fibers, some seven or eight in number, but loosely connected together, and among which, to all appearances, no anastomoses take place.

In fishes, as we are aware, two types can be distinguished, depending upon the relations existing between the nerve center of the olfactory organs and their terminal filaments. In one case the bulbi olfactorii of the olfactory mucous membrane lie close by, and are connected with the fore brain by a long tractus; a single olfactory nerve does not exist in this case, but rather, on the other hand, quite a number of short nerve fibers pass from the bulbus to the olfactory mucous membrane. In the other case the bulbi olfactorii are connected with the hemispheres of the cerebrum and arise as long and true olfactory nerves. At first sight it would appear as though the difference was not an essential one, and as though the bulbus olfactorius was no integral part of the brain, but simply a collection of ganglionic cells occurring in the course of the fibers of the olfactory, and could occupy divers positions. That it is, however, is clear when we see the typical, very characteristic, difference between the stout olfactory nerve, provided with a firm neurilemma, and distributed to the periphery from the bulbus, and the thin tractus, enveloped only in the delicate pia mater holding a central position with respect to the bulbus. This same fact was particularly dwelt upon by Stannius,[43] that these two specified conditions as regards the position of the bulbi olfactorii are always independently present, that there is either a bulbus adjacent to the brain or one annexed to the olfactory membrane; cases in which a centrally located bulbus occurs in connec-

[43] Stannius, *Das peripherische nervensystem d. Fische*, 1849, page 2. [Stannius, The Peripheral Nervous system of Fishes, 1849, p. 2.]

tion with ganglionic enlargements at the distal extremity of the olfac. troy nervelets do not exist.

Besides, there are—though very rare—intermediate forms known between the two types we have indicated among fishes; cases, for instance, where the bulbus is placed half-way between the brain and the olfactory membrane, and where it is connected with the former by a thin, soft tractus; with the latter by a strong, firm nerve at least four times as thick. The only other case of this kind known up to the present time has been noticed by Stannius in the *Gadus raniceps fuscus;* and I find quite a similar condition in the Characinidæ, as in *Hydrocyon* and *Alestes.*

A mere superficial examination of these two types does not furnish us with sufficient data to judge from, and decide which is the primary form and which is the derived one. As in so many other cases, the question can only be decided by the systematic—based upon other conditions of organization—position of the forms that belong to one or the other type. We now find that the first type occurs in all Selachians, in Holocephals, and certain of the Teleostean groups, long known to us as the primitive forms, as in the Siluroids, the Cyprinoids, the Gadidæ, and, as I have found, also in the Mormyridæ.

The second type is extensively found in the Ganoids and in the great majority of the Teleosteans. With all this before us, no doubt can remain that the first type is the primitive one, and that from it the other type has developed by a gradual shortening of the tractus and a lengthening out of the nerve.

It appears that in the Teleosteans the development of the olfactory nerve is always brought about in the same way and with a uniform result. The enlargement of the orbits leads to a fenestration of the lateral orbital wall at its anterior angle near where the bulbus olfactorius was originally located, as one can see very well in the Characinides; this development extending further gives rise to an olfactory nerve, which must of necessity pass through the orbits. These conditions appear to be quite constant among the Teleosteans. Among a great number of very diverse forms I have always found either an olfactory nerve in the orbit or a long tractus extending directly from the brain case to the nasal pit.

In *Hydrocyon*, already referred to, the bulbus lies in a special elevation in the orbito-sphenoid; from it a nerve is given off that passes to the olfactory membrane, being free in the orbital cavity; and a long tractus lying within the cavum cranii to the fore-brain, so that in this case there is no exception to the general rule.

A remarkable exception to this rule is found in all the Ganoids. In these fishes a true olfactory nerve passes within the direct continuation of the brain case, and consequently proves to be a condition that must have arisen under circumstances to us nearly unknown and entirely

different from those of the bony fishes, and, therefore, bears no genetic relation to the latter.

Lepidosteus alone seems to form an exception to this unvarying rule among the other Ganoids. The olfactory nerve in *Lepidosteus* at first passes into a tunnel-shaped osseous tube, formed by the alisphenoid. At the posterior part of the orbit it quits this tube and passes close beside the semicartilaginous, semimembranous interorbital septum; consequently at this point its course is free in the orbit. At the anterior part of the orbit both nerves enter a very long cartilaginous double tube, which corresponds to that portion of the long rostrum of this fish belonging to the primoidal cranium. At first glance we seem to have presented us here a method of development corresponding in every sense with that seen in the majority of bony fishes, yet this is by no means the case. As already stated, the fenestration of the lateral wall of the skull in the nasal region of bony fishes begins at the anterior part of the orbit, at the place where the bulbus olfactorius occupies a near position to the olfactory mucous membrane, and which leads to a marked separation of the same from the membrana olfactoria, and to the lengthening of the olfactory nerve. In *Lepidosteus* this long double tube, in which the nerves are contained, is to be considered as the original direct continuation of the skull cavity; therefore the development of an interorbital septum in this fish cannot have come about in the same way that it did in the bony fishes, nor can the necessity for the origin of the olfactory nerve be looked for in this fenestration. This nerve must have originally in *Lepidosteus*, as well as in the other Ganoids, been contained for its entire length in a continuation of the brain case, which was separated by a median dividing partition into two canals; subsequently the lateral partition in the posterior interorbital part of this septum disappeared, and in this way the olfactory nerve came to lie in the orbit.

In the course of this essay it would have been quite an easy matter for me, in more instances than one, to have pointed out the facts going to show that quite a number of the various structures in the bony fishes can be traced with tolerable certainty to *Amia*, and from this the opinion naturally arises that the same will apply to all the organs, and that *Amia* is in reality a direct ancestor of the family of Teleosteans.

For this reason I have the more eagerly seized upon the opportunity to point out the conditions referred to above with respect to the development of the olfactory nerve, in which particular *Amia* has decidedly reached a higher degree of organization than certain osseous fishes lower down in the scale.

In this place I will not omit the consideration of the morphological conditions of the peripheral olfactory organs of the Ganoids and Teleostei somewhat more critically, and compare them with corresponding conditions in the Selachians.

In the lowly organized Sharks, as, for example, the Notidanides and Acanthias, there exists upon the inferior aspect of the snout, on either side, a single nasal aperture, which is incompletely divided by two processes, the nasal flaps, which spring from its margin, and give rise in this way to a medial and a lateral entrance.

In the more highly organized Selachians, in the Scyllians, among the sharks, and in many rays, a more or less deep groove is found to extend from the medial entrance to the upper margin of the buccal aperture. This is the well-known naso-labial groove, which also appears in the ontogeny of the higher vertebrates, and for the closure of which the median nasal aperture is furnished with a valve, found on the margin of the upper lip and opening in the direction of the nasal cavity. This latter corresponds to the inner nasal opening of the Dipnoi, Amphibia, and Amniota. These structures have long since been described by Gegenbaur, and the question only concerns us with respect to the Teleosteans and Ganoids.[44] According to previous notions—still accepted by Gegenbaur—the two openings of the nasal pit in bony fishes and Ganoids correspond to the imperfectly separated nasal valves of the lowly organized Selachii. Balfour[45] has placed a different interpretation upon this. According to his views in the matter, the posterior nasal aperture of the higher fishes are homologous with the inner nasal apertures of air-breathing vertebrates, which by a gradual turning of the axis of the nasal capsule have shifted their position from the upper lip to the superior aspect of the head.

My observations upon fishes compels me to oppose this view, and adhere to the old opinion. There are two arguments that I must cite which conflict with Balfour's notion: one of comparative anatomy and one of the history of development. In a number of Teleostei, among others, all native Cyprinoids examined by me, I found in the immediate neighborhood of the nasal apertures and in the dermal bridge separating the anterior and posterior aperture, a small cartilage, that remained undescribed up to the present time, and that is strictly homologous with the nasal alar cartilage of the Selachians. This cartilage usually has the form of a figure 8, the two loops surrounding the nasal openings and the middle piece lying in the dermal bridge between the apertures. It is very intimately connected with the skin, so that it becomes a difficult matter to make a dissection simply trusting to the scalpel and forceps, but by the aid of a microscope, and carrying the incisions through the nasal region, one can very easily satisfy himself of its presence. It possesses the characteristics of hyaline cartilage and differs

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[44] C. Gegenbaur, *Grundzüge der vgl. Anatomie, II Aufl.*, 1870, pag. 754, *und das Kopfskelet der Selachier*, 1872, pag. 97 *u* 216. [C. Gegenbaur, Elements of Comp. Anatomy, II Edit., 1870, page 754, and the skeleton of the Selachian head, 1872, pages 97 and 216.]

[45] F. M. Balfour, Manual of Comparative Embryology, 1881, Vol. II, page 477.

from the cartilage of the primoidal cranium, with which it is in no way connected, by its much denser cartilage cells.

In many cases among the Selachii, too, does the nasal alar cartilage encircle these apertures as a ring, sending out processes into the nasal valves. If one pictures to himself that the nasal valves of the Selachians have become merged with each other during their growth or development, and the cartilaginous processes contained within them become blended, there will result as a consequence a condition that can in no way be distinguished from the state of things as seen in the Teleostei. That this view is the correct one is shown by the history of the development of the nasal organ in the bony fishes.

In newly-born fishes there exists on either side a simple undivided nasal aperture, as I have observed in the *Lota vulgaris*, in the Pike, in the Trout, and in the *Chondostroma nasus*. It is not until these forms have passed the embryonic stage does there occur, sooner or later, a division of this aperture into anterior and posterior nares. Both the median and lateral periphery develops a small patch of skin, directed towards the center of the aperture. Very soon these processes that correspond to the nasal valves in the Selachii become contiguous, the lateral process being behind the median in all of the specimens examined by me. At this stage the nares in osseous fishes have reached the precise condition that remains permanently in Notidanides and *Acanthias*.

In a short time these two nasal valves of bony fishes blend together and the narial opening receives its definite shape, at least for those forms in which the two apertures are situated close to each other. Inasmuch as the primary conditions are not exactly so arranged in *Lota vulgaris*, whose anterior and posterior nares, after it has arrived at maturity, are far removed from each other, there must occur in this species a widening of the nasal bridge and a separation of the nasal apertures at a later period (unfortunately I lack the material to illustrate these stages). At any rate fishes with the anterior and posterior nares close together are to be considered as primitive forms, and from such, forms can be traced in which these apertures are far apart. Such forms, then, are to be considered as the highest in the scale of development in a certain direction, in which the narial apertures are far apart and are situated on the upper lip.

Such formations among bony fishes occur in *Ophisurus* and kindred forms,[46] in the family of Murænoids, and, in fact, they have at the first glance a certain resemblance to corresponding structures in Dipnoi and perennibranchiates, and it does not appear improbable to me that this peculiarity of the *Ophisurus* led Balfour to assert a homology of the

[46]Lütken, *Nogle Bemaerkninger om Naeseboreunes Stilling hos de i Gruppe med Ophisurus staaende Slaegter af Aale familien. Videnskabl. Meddelelser fra d. naturhistoriske Forening i Kjöbenhavn*, 1851.

posterior nasal aperture in osseous fishes with the posterior nares of the air-breathing vertebrates.

A comparison extended to a greater number of forms and the history of development clears up the actual state of affairs in this case also, and demonstrates that it is but an interesting case of "converging development" ["*konvergenten entwicklung*"]. The position held by those Teleosteans which permanently possess but one nasal aperture on either side, as for example *Belone*, the Pomacentrides, many Chromides, &c., is only to be determined with absolute certainty when we have a knowledge of the history of their development. If one, however, considers that the nearest kin to these fishes (Cyprinodonta, Labroidæ) exhibit the ordinary conditions, it will hardly be out of place to simply assume that the dividing dermal bridge between the nasal apertures in the form referred to has been secondarily reduced.

As in so many other structures, so in those of the nasal apertures, the lowly organized Selachii prove to be the starting point from which two diverging series can be traced; upon one side the higher fishes, on the other the air-breathing vertebrates.

As I have already mentioned, the anterior and posterior nares in *Amia* are far apart, and, consequently, *Amia* represents a form that must, as compared with the ordinary bony fishes, be accepted as possessing a higher state of development. The *nasal bone* is imbedded in the broad dermal bridge between the two nostrils. Under these circumstances it is not at all strange that, in spite of the careful search I made for it in this fish, I could not find the trace of a nasal alar cartilage in the vicinity of the nostrils. The nasal has taken upon itself the original function of the same, that is, to support the entrance to the nares, and thus rendered a nasal alar cartilage superfluous.

To conclude the present article it only remains for me to draw a comparison between the cranium of *Amia* and that of the Selachii, with which it may best be compared, and to particularize their resemblances and their differences. Taken as a whole the latter are fewer in number than one would at first suppose. The fundamental difference between the skull of *Amia* and that of the Selachians rests upon the appearance of the large connecting ossifications in the former. These ossifications either simply overlie the primoidal cranium, or they are connected very intimately with it, and without changing their form, replace structures in it that were originally cartilaginous.

The first appearance of the larger uniting masses of osseous tissue among fishes denotes one of the greatest and most far-reaching steps in the progress of the process of development of vertebrate animals. It indicates the first appearance of a tissue that, as a protective and supporting material, proves far more suitable than cartilage. A glance at a series of skulls of Selachians and Teleosteans will be sufficient at once to demonstrate the great significance of this "occurrence."

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The entire organization has become changed. A pleasing, graceful structure has taken the place of the clumsy Selachian skull. The delicate and rounded contours of the latter are replaced by angular, and quite often by oddly-shaped skulls, on which the grooves for muscular attachment and tendon insertion are distinctly marked. The new material substituted for the building up of these structures far surpasses the old, not only in its capacity for resistance, but also is greatly superior to it in its fitness for plastic modelling. In this particular, one finds very marked gradations even among the higher fishes. In their rounded contours, and in the imperfectly developed muscular grooves and crests, the bony Ganoids and a number of the Physostoma remind one very much of the Selachians; and it is only in those groups of fishes exhibiting the highest development, more particularly Acanthopterygii, that the types of extreme differentiation come into bold relief.

Leaving out of consideration the fact that it partly consists of different material, the primoidal cranium shows but few points of difference from that of the Selachii. In the first place, by the co-ossification of several vertebræ, the occipital region in *Amia* has attained a distinct morphological value, differentiating it from the corresponding regions in the Selachians, without having its form essentially changed by the process. Compared with the Selachians it has increased considerably, but in length only, which is sufficiently accounted for by the circumstance just mentioned.

The posterior part of the skull cover, in the vicinity of the occipital region, presents a structure that already esssentially exists in the Selachii. The median, cartilaginous process, pointing posterially, is present in the Notidanides, being developed there as a cartilaginous crest. Nor is it difficult to recognize in the medial projections occupied by the exoccipitals in *Amia*, the cartilaginous elevations developed upon the projecting posterior arches of the Selachians. The posterior lateral angles of the skull, formed in *Amia* by the intercalare, are also very well developed already in some of the sharks, as, for example, in *Scyllium*. Between the crest of the posterior arch and the last-mentioned lateral projection of the skull in the Scyllia there can already be recognized a depression in the cranical vault, extending into the region of the postorbital process, which in *Amia* is bridged over by the overlying dermal bones, closing in the temporal fossæ. In the region of the labyrinth of the Selachians we find this cavity closed up on the side towards the cavum cranii; in *Amia* it is widely opened, probably a fenestration proceeding from the periphery of the acusticus foramen.

Upon the outer aspect of the labyrinth region, the changes occasioned by the presence of the articular facet for the hyomandibular, are the most striking. I have already availed myself of the opportunity to point out, in the higher fishes, the extension of the hyomandibular forwards as far as the postorbital process.

At this point I would remark, that in the matter of position of the hyomandibular articulation, it is the Notidanides among all the Selachians, that still most resembles *Amia* and the Teleostei.

The parietal grooves which occur in the skull cover of many Selachians, and which include the broad, blind terminal parts of the aquæducti vestibuli, are missing in all the Ganoids and Teleosteans. This has evidently something to do with the very imperfect development of the aquæducti in the higher fishes as compared with that structure in the Selachii.

At the base of the primoidal skull we invariably find in higher fishes a fenestration in the region of the hypophysis cerebri that is lacking in the Selachii.

Postorbital and antorbital processes occur in most of the Selachii as well as in *Amia* and most all the Teleostei.

The optic foramen of the Selachii—already exhibiting evidences of increasing size—is represented in the orbital region of *Amia* by an extensive vacuity.

The cartilaginous peduncle which supports the eye in many Selachians, is in *Amia* reduced to a fibrous cord. Only the merest traces exist in the orbits of *Amia* of that basal projecting ledge of the primoidal cranium and the vault as they occur in the Selachii.

The very characteristic vacuity which occurs in the prefrontal coverbone of the primoidal skull in the Selachii is wanting in *Amia*, but appears to be present in certain families of osseous fishes, in Cyprinoids and Characinids.

Not a few differences in the structure of the nasal region between the Selachii and the higher fishes, including *Amia*, can be made out. While the nasal apertures in the Selachians are situated upon the lower aspect of the snout, in higher fishes they are without exception on the lateral or upper plain of the head; besides, the well-developed nasal capsules of the Selachii are reduced to quite flat pits in *Amia* and in the bony fishes.

A structure homologous with the nasal alar cartilage of the Selachians is entirely wanting in *Amia*, but can be pointed out, as demonstrated above, in certain bony fishes.

Still another, not unimportant, difference in the structure of the nasal region in the higher fishes and that of the Selachians is to be recognized in the fact, that in the former articular facettes for articulation with the anterior end of the palatine arch are developed on the inferior aspect of the region referred to.

The characteristic interrupted rostra, occurring in many Selachians, are wanting in the higher fishes, either entirely or are replaced by simple uninterrupted structures, that approach in this respect the rostra of the Notidanides.

The recapitulation of our investigations go to prove that there are several structures in the organization of *Amia* that cannot be regarded

as having been derived through progressive development from existing structures in the Selachii.

To these belong the diverse courses of the ramus palatinus in the Selachians and in the higher fishes, the relations of which cannot be directly derived from one another. Yet it is not improbable that in this case we are dealing with a substitution of very different and appreciable nerve branches, as often happens in fishes.

In most of the plans of structure in the skull of Amia a direct progress in development can be discerned in parts from those that already exist in Selachii; and it is particularly the Notidanides—the least differentiated of the Selachians—which present the most evident relations to Amia for recognition.

It would be very difficult to specify the distinguishing characters between the cranium of *Amia* and that of the Teleostei. There are but very few characteristics to be found in the skull of *Amia* that could not be found in one or the other of the families of the Teleostei, and these few distinguishing characters are not restricted to *Amia*, but are also found in other Ganoids. In this category belongs the continuate, nonfenestrated, cartilaginous cover of the primoidal skull, in which, among the Teleostei, vacuities are always discoverable, but it has preserved its integrity in the Accipenserides among the Ganoids. A second important distinction is the absence of the supraoccipital in *Amia* and all the other Ganoids, while in the Teleostei it occurs quite constantly. The third distinction—already described above—refers to the course of the olfactory nerve in a direct prolongation of the brain case—is shared by *Amia* with all the other Ganoids.

POSTSCRIPT.—Just as this article had passed into the hands of the printer, I received a copy of the treatise by J. Van Wijhe, "Upon the visceral skeleton and the nerves of the Ganoids" (Netherlands Arch. f. Zoolog., Vol. V., Part III, 1882), in which the cranial nerves of *Amia* are described. I am glad that Van Wijhe agrees with me in all the essential points. I must also state that Van Wijhe has invited attention to the importance of the mucus canals in determining the bones that overlay the skull (*l. c.*, page 228).[47]

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[47] Dr. Sagemhel's paper is completed by a *résumé* of the lettering of the figures, or an "Explanation of figures in the plate," but I have omitted this, as the figures are separately described in their appropriate places here.—TRANS.

PART II.

Henricus Franque, doctor of medicine and surgery, published his famous monograph, entitled Amiæ Calvæ, Anatomian Descripsit Tabalaque Illustravit, in Berlin in 1847. The pamphlet form of this unique paper, familiar to all anatomists who have worked upon or are interested in the osteology of fishes, now lies before me. It extends through seven pages, written in Latin, upon the skeleton of *Amia calva*, with references to some of the soft parts; description of figures in the plate, and the plate itself. This latter presents eleven figures, four of which are devoted to the skeleton; Fig. 9 to a scale; while the remainder illustrate various things in the soft anatomy. Fig. 1 is an upper view of the skull, with all the "cover-bones" retained in their normal positions. In Fig. 2 we are presented with a left lateral view of the entire skeleton of a moderately sized fish of this species. Fig. 3 gives an inferior view of a part of the cranium, with the entire hyobranchial apparatus removed.

These figures are all well done, and in a style peculiar to themselves, bold and clear, though lacking in some points of minute detail. Three of these figures have been copied for me by Mr. H. L. Todd, and reduced by photograph for the purpose of adding to this article the figure of the lateral view of the entire skeleton. This will be valuable in showing the general relation and arrangement of the bones.

The excellent article of Bridge[48] is good as far as it goes, but he treats of the skull of *Amia* only, and we still have to resort to other works to study the extremely interesting points in the remainder of the skeleton. Moreover, as Mr. Bridge's paper was published in the Journal of Anatomy, it is not particularly available to a very large number of American workers. Indeed, this valuable periodical is not subscribed for by nearly as many of our libraries and institutions as it should be, nor as it deserves to be. To present a good account of the entire history of the skeleton of *Amia* is the principal object I had in view upon undertaking the present paper. Just previous to Dr. Sagemehl's paper, which constitutes Part I of this memoir, Bridge very truly tells us, in his article, when reviewing all that anatomists had done with the skeleton of this Ganoid up to 1877, that "the cranial osteology of living Ganoids has been hitherto but partially investigated; and even those genera that have been described by the older anatomical writers will abundantly repay renewed investigation now that the researches of Parker, Gegenbaur, and Huxley have thrown so much light upon the morphology of the vertebrate skull."

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[48] Bridge, T. W.—The Cranial Osteology of Amia Calva. Jour. of Anat., normal and pathol. Vol. XI, Pt. IV, page 603. Edinburgh and Lond., July, 1877.

"Agassiz,[49] it is true, has given to us an elaborate account of Lepidostens, and the earlier description of Polypterus by H. Müller[50] has been supplemented by Dr. Traquair's[51] opportune paper; while to Dr. Günther and Prof. Huxley[52] we are indebted for exhaustive accounts of the skeleton of Ceratodus."

"On the other hand, I am not aware that, beyond the more or less brief accounts to be found in John H. Müller's *Vergleichende Anatomie der Myxinoiden*[53] we have any detailed descriptions of Spatularia, Acipenser, or Amia; and the anatomical student who may wish to acquire any complete knowledge of these genera must content himself with the above-mentioned references, or with such facts as he may be able to glean from such anatomical text-books as Huxley's *Manual of Vertebrata*, Owen's *Comparative Anatomy*, or the *Grundzüge der Vergleichenden Anatomie* of Gegenbaur. More especially is this true of *Amia*. The zoological characters of this genus have been described by several Zoologists. Vogt[54] first detected its true position among the Ganoids and removed it from the Clupeoid Teleostei, with which it had been placed by Müller;[55] and Hyrtl[56] and Franque[57] have described the generative organs and visceral anatomy. But I am not aware that there exists any connected account of the osteology of the skull of this genus, or that the skull has been figured."

Jordan and Gilbert place the *Amias* in the order Halecomorphi, and the single species known, the subject of this paper, *Amia calva*, in the only family in the order, Amiidæ. These authors give as the geographical range of this fish the great lakes and sluggish waters from Minnesota to Virginia, Florida, and Texas. In describing the external appearance of *Amia calva*, they state that it is of a "dark olive or blackish above, paler below; sides with traces of dark reticulate markings; lower jaw and gular plate often with round blackish spots; fins mostly dark, somewhat mottled. Male with a round black spot at base of caudal above, this surrounded by an orange or yellowish shade. In the female this spot is wanting."[58]

On the 12th of February, 1883, I took in a seine near New Orleans, La., four specimens of *Amia*. Two of these were alike; they were very dark above, the ocellation at the base of the tail, large, very black, and the emargination a brilliant buff color. But what was still more strik-

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[49] Agassiz, Poiss, Foss, Tom. 11.

[50] *Abhandl, A. K., Wiss.;* Berlin, 1844.

[51] Journal of Anatomy, Vol. IV.

[52] Phil. Trans. 1871; 5 Proc. Zool. Soc. 1876.

[53] *Vergl. Anat. d. Myx.*, Berlin, 1835.

[54] *Annales des Sciences Naturelles*, Tom. XXIV, Heart and alimentary canal figured.

[55] Müller's paper, "*Sur les Ganoides et sur las classification naturelle des Poissons,*" is translated by Vogt in the XXV. vol. Ann. Sci. Nat.

[56] *A. K. Wiss. Wien.*, 1855.

[57] *Amiæ calvæ Anatomia*, Berlin, 1847.

[58] Jordan & Gilbert. Syn. Fishes of North Amer. Bull. U. S. Nat. Mus., No. 16, 1882.

ing, and what differs from Jordan and Gilbert's description, the pectoral and ventral fins in these two specimens were of a bright Prussian green. The two remaining specimens were smaller fish, much lighter in color, being sort of a clay-brown, with the fins of a similar shade, and less mottled than the others, with the caudal ocellation present, only not so large or brilliant.

OF THE GANOID PLATES.

This series of investing bones of the cranium have been so thoroughly described by Sagemehl above, and by Bridge in the Journal of Anatomy, that I shall content myself with a running review of them, with special references to the fine specimen before me, from which I made my drawing. (Plate IV, Fig. 16.)

The most extraordinary thing about Bridge's description is that he seems to have secured a specimen for his dissection, wherein the parietal dermo-plates were in one piece, without any trace of a suture between them. To the united bone this anatomist gave the name of the dermo-supraoccipital, which is commented upon by Dr. Sagemehl in Part I of this paper.

It seems hardly possible that Bridge could have been mistaken in this matter, as he made special search for the sutural trace dividing them, aware as he was of Owen's already having mentioned that two plates occupied the site of his dermo-supraoccipital. Moreover, the sculpturing would be different on a single plate, as the rugosities would radiate from a single center to the borders as they do in the other plates.

In all the specimens that I have examined, including the one before me, these parietal plates, existed as described by Dr. Sagemehl, even to the detail of the suture not terminating in the median line posteriorly as shown in Plate I, Fig. 1, *Pa.* This was the condition found and described also by Franque, who gives a very good representation of a superior view of the dermal plates in this fish. (Plate II, Fig. 7.)

The arrangement in my specimen is precisely the same as in the specimen drawn by this latter anatomist, the right-hand plate extending more anteriorly and the suture between the bones deflected to this side posteriorly. Figure 7 should show, however, more marked serrations of the margins of the bones anteriorly, as they are invariably found to be so in nature.

External to the parietal plates on either side we find a longer and narrower bone, sculptured as the rest, which is the *squamosal.* (Plate IV, Fig. 16, *Sq.*)

Behind the squamosals and parietals, the hinder margins of which form nearly a straight suture across the skull, we find the *supra-temporals*, two rather long, triangular plates placed transversely with their blunted apices meeting in the median line (Fig. 16, *S. tp.*). These two plates shut out from superior view the two forked limbs of the posttemporals upon which they rest.

Of all these plates on the superior aspect of the skull the frontals are by far the largest. Posteriorly they articulate with the squamosals and parietals as already described, while on either side they make room for the postorbitals. (Plate IV, Fig. 16, *Fr.*)

Their anterior bodies are separated from the hinder margins of the nasals by a considerable interspace. This is bridged over by a delicate membrane, which is continuous with a similar tissue that extends across the gap between the frontal and lacrymal on either side (Plate IV, Fig. 16, *jn.*). In prepared skulls where this structure is allowed to remain and dry it becomes very thin, and by cutting through it we expose the posterior narial apertures and the primoidal cranium beneath.

The nasals are oval bones that articulate with each other in the median line by means of a markedly dentate suture. Wedged in between them anteriorly we find the azygos and subtriangular ethmoid (Plate IV, Fig. 16, *Na.* and *Eth.*). Upon the outer side of each nasal, in my specimen, there lies a smaller plate, of a spindle-like form, that corresponds to the plate described by Bridge as the preorbital, although its posterior end occupies a point only about half-way distant between the teeth and the anterior margin of the orbit (Fig. 16, *An.*). This author also figures a small ossification below this preorbital, which does not occur in my specimen. Dr. Sagemehl seems to have found a like structure, but attached no significance to it.

Bridge describes the ethmoid very concisely when he says, "The dermo-ethmoid (*Eth.*) is somewhat T-shaped, with its anterior transverse part slightly concave from side to side. It overlies the prenasal process and the premaxillæ. Each end of the transverse part is in contact with the preorbital bone, while the stem of the T passes backwards between the nasals, separating them for about a third of their extent."[59]

The periphery of the orbit is subelliptical in outline, and six of the dermo-plates contribute to its boundary. The upper half of the circumference is formed by the free margin of the frontal, as the vault of the orbital cavity is made by this bone. Its lower half is bounded by the five remaining plates, of which the superior postorbital is the largest, and the rear suborbital the smallest, though the latter contributes the greatest share to the peripheral circumference.

The most anterior bone of this suborbital chain, I call, in common with other anatomists, the *lacrymal*, as it is quite constant in the class, both in the position it usually occupies and its occurrence. The two smaller plates, immediately beneath the orbit, are true suborbitals, and their number and arrangement vary greatly throughout all fishes.

Behind the large triangular *postorbitals*, we find a group of small bone-plates, forming a vertical chain, that fills in the space between these bones and preoperculum (Plate IV, Fig. 16 *k*, *k'*, *k''*). These small plates seem to vary in their size, form, and number, for on the opposite

[59] Jour. of Anatomy, July 1877, page 608.

side of my specimen I find but one of them, which is situated just below the squamosal and shaped like the one marked k'' on the right side.

All four of the *opercular bones* are present and thoroughly developed. (Fig. 16, *Op.*, *S. op.*, *I. op.*, *and Pr. op.*)

The *preoperculum* is a long, narrow, crescent-shaped bone, that touches the squamosal above and contributes to the articulation for the mandible below. Only a narrow strip of its external surface, just within the posterior border, along its entire length, shows the sculpturing common to the other bones. Beyond this its surface is smooth, and its anterior border makes a very intimate union with the hyomandibular and symplectic.

The three remaining opercular bones are beautifully sculptured all over their external surface, and remind one not a little of those rugose surfaces as seen in some of the handsome marine shells. Of these bones the *operculum* is by far the largest; it articulates with an elongate facet, placed upon the upper and posterior angle of the hyomandibular. In common with the remaining two of the group, its anterior border is overlapped by the preoperculum. The upper and lower margins of the *suboperculum* are closely applied throughout their entire extent to the opposed margins of the operculum and interoperculum. This element is of a more irregular form than either of the others, its upper border being deeply concave to admit the rounded lower anterior angle of the operculum, while the inferior one is quite straight. Against this last, the base of the *interoperculum* is applied, this latter plate having somewhat the form of an isosceles triangle, with its rounded apex directed below. The inner surfaces of these three last opercular bones are smooth and unmarked by any sculpturing, as their opposite sides are. A rounded ridge crosses the suboperculum obliquely, extending from its upper posterior angle to the lower anterior one. Anteriorly, the extremity of the *maxillary* (Fig. 16, *Mx.*) is bent towards the median line, and articulates in a socket immediately behind the outer end of the premaxillary, being covered over above by the preorbital and lacrymal plates. Its entire lower margin is armed with a single row of thickly set teeth. These decrease in size from before, backwards, and, like the larger ones on the premaxillary are very sharp and gently curved inwards. The hinder half of the upper border of the maxillary supports an additional thin plate of bone, as seen in so many of the Teleostei. This is the *admaxillary*, and its form is very much the same as in bony fishes (Fig. 16, *a*). Both the maxillary and admaxillary are sculptured on their outer surfaces after the fashion of the other ganoid plates described above.

Bridge says: "In comparing the skull of *Amia* with the skulls of certain of the Siluroidei, and notably with that of Clarias, it is interesting to notice that, in addition to the more obvious and less important points of resemblance between the two genera necessitated by the flattened condition of the head and a foreshortening of the prefrontal

region, there is a close agreement between them in the number and relations of their ganoid plates."[60]

Of the Mandible.—A lateral figure of this very complex bone presents us with a partial view of four of the elements that enter into its composition (Fig. 16). As usual, the chief part of the ramus is made up by the *dentary* (Fig. 16 and Pl. V, 17, *D* or *d*). This bone expands behind to articulate with the angular and surangular on lateral view, while internally this expanded part is broadly concave, which concavity is arched over by the splenial. Anteriorly, it meets the fellow of the opposite side in a rather strong symphysis, the two bones developing a single row of powerful teeth. These are of a conical form, curved backwards, and very sharp at the apices. In Fig. 16 is shown where two of these teeth have been shed, and the shallow pits they leave behind them. The row of smaller teeth beyond, as shown in this figure, belong to the splenial or the plates connecting it with the symphysis. Upon lateral view we may also see the angular and surangular to the extent shown in Fig. 16, as well as the ossification marked *z* to be described further on.

The *angular* is the next in point of size to the dentary. Its outer surface is convex and sculptured in the same manner as the ganoid plates, while posteriorly it forms part of the articulation of the jaw.

Above this element we find the *surangular* splint, which is carried up to form the coronoid process, to be tipped with cartilage at its apex.

Bridge, after his careful investigation of the mandible, says, in his paper quoted above, that it "is an unusually complex structure, as each ramus consists of not fewer than fourteen distinct elements. Meckel's cartilage persists as a thin axial band of cartilage. Its distal end is ossified, and forms a small cylindrical mento-meckelian ossicle (Plate V, Fig. 17 of this paper, *mt. mk.*), which lies in a groove on the inner side of the symphysial end of the dentary (*d*). The proximal end of the cartilage is the seat of at least four distinct ossific centers. Of these, three are arranged in a linear series proceeding from the angular extremity of the mandible. These are referred to in the annexed plates [figures] as *a*, *b*, and *c*. Of these the ossicles *a* and *b* form the anterior and posterior boundaries of the articular cup for the quadrate, and are separated from each other by that portion of Meckel's cartilage which forms the bottom of the cup. The bone marked *c* is much smaller than the other two. That part of Meckel's cartilage adjacent to the articular cup is produced vertically upwards and forwards into a well-marked 'coronoid process' (*cr*). The base of this process is the seat of an ossification (*b*) which forms the outer side of the articular cup, and fits into the cup-shaped distal end of the preoperculum. Thus these three bones, *a*, *b*, and *c*, contribute to the formation of the concave articular surface for the quadrate."

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[60] *Ibid.*, page 609.

"Hitherto it has been currently stated in anatomical text-books that the mento-meckelian bone at the distal end, and the articular bone at the proximal end of Meckel's cartilage, were the only elements of the mandible really formed by ossification of the cartilage itself, yet in Amia there can, I think, be but little doubt that at least four, and probably five, ossific centers are developed in the axial cartilage. Whether one of the centers *a*, *b*, *c*, and *d* represents the os articulare of the Teleostean mandible, or whether the latter bone is really a compound bone resulting from the coalescence of the persistently distinct elements of Amia, is not very evident; but I am inclined to think that the os articulare is not so simple a bone as it has hitherto been supposed to be. As the Meckelian cartilage is the distal, or ventral half of the first postoral visceral arch, though it may not be possible to point out the special homologies of the mento-meckelian, and the ossicles *a*, *b*, *c*, and *d*, with the ossifications found in the ventral halves of the remaining postoral arches, yet I think that we may roughly correlate those ossicles with the interhyal, epihyal, ceratohyal, and hypohyal of the hyoidean series."

"It may also be that the cartilaginous 'coronoid process' is another instance of the tendency manifested by the first postoral arch to develop forward connective outgrowths, of which the orbitar process and the palato-pterygoid arcade are conspicuous examples in the proximal half of this arch. In addition to the mandibular elements above referred to there are, in addition, several membrane bones. The ossification *a* has a small ganoid plate (*d. a*)[61] attached to it, which appears at the extreme tip of angle of the jaw."

I show in Plate V, Fig. 18, the large triangular splenial *in situ*. This bone does not run out to the symphysis of the rami anteriorly, but is indirectly connected with it on either side through a chain of five very much smaller plate-like bones. These each support a tuft of good, strong teeth, and very much remind one of the dental plates arranged along on the superior aspect of the branchial arches. I am surprised that Bridge did not notice this when he compared the numerous ossifications of Meckel's cartilage with these arches, as the simile is equally striking. Teeth are found also over quite an extensive area on the upper part of the splenial, though here they are very fine indeed (Fig. 18). When the splenial is in position, a large subcompressed conical space is inclosed between it and the outside bones. The base of this cone is directed inwards and forms the opening to the sulcus in question. Both the symplectic and the preoperculum contribute to form the cup for articulation with the mandible, and the quadrate supplies an articular semi-globular head for the same purpose. As already described, the opposed surfaces on the jaw are developed from special ossific centers.

[61]This is the ossicle marked *z* in Fig. 16 of this paper

A large azygos *gular plate* partially fills in the inter-ramal space (Pl. VI, Fig. 20, *G. pl.*). This plate, occupying as it does the same position as the paired structures of similar description in Polyterus, is held to the surrounding bone by the skin and other soft parts. Its anterior end develops an expanded tip, which is connected by stronger ligament to the symphysis of the jaw. Externally, the surface is sculptured like the ganoid plates on the roof of the skull, while its internal surface is quite smooth. The homology of this plate is still unsettled. It has been spoken of as replacing the urohyal. A very long, osseous gular plate is found in the inter-ramal space among the Elopidæ.

Of the Cranium.—So minutely has Dr. Sagemehl described this part of the skeleton of *Amia calva*, that I will here but hastily view the points for examination, and introduce them merely as a recapitulation to fill in my own account of the skull.

To examine the cranium we must take the head of a fresh specimen, remove the shoulder-girdle, all the ganoid plates, and other structures below and laterally that do not belong to it. Then, from a superior view, we have presented us for examination a large, central quadrilateral, cartilaginous track (Fig. 6). At the anterior extremity of this, we see the intermaxillary (*Sm.*); the premaxillary (*Pmx.*), and the prefrontal (*Prf.*). Occupying a lateral and at the same time a mid position we see the postfrontal (Fig. 6 *Psf.*), while it is bounded behind by the *opisthotic* at the outermost angle (Fig. 6 *Jc*, intercalare, Sagemehl, *op. o*, opisthotic of Bridge), just within which, and above it, we find the exoccipital (*Ex*)—this latter is marked *ep. o.* in Bridge's figure, he considering it the epiotic. Behind these two bones we observe in Fig. 6 a segment marked *Ol*, this is the *occipitale laterale* of Sagemehl, and the exoccipital of Bridge. To the rear of this again we find the occipital arches, so well described by the former author in Part I of this paper.

Now, turning the cranium over, we have presented us upon its inferior aspect, for examination (Fig. 2), first, the pair of *vomers* (*vo.*), situated anteriorly; then traversing the basis cranii longitudinally the parasphenoid *Ps.* (*pa.s* in Bridge's figure). An almond-shaped area in the middle of this latter bone is covered by fine teeth, while the anterior thirds of the vomers support others which are very much larger and arranged in a circular group. The vomers and parasphenoid must now be carefully removed; then we have before us the ossifications shown in Fig. 3—the base of the cranium. Proceeding from before backwards, there are the premaxillary (*Pmx.*); the septo-maxillary (*Smx.*); the prefrontal (*Prf.*); the orbito-sphenoid (*Os.*); the alisphenoid (*As.*); the postfrontal (*Prf.*); petrosal (*Pe.*) (the *proötic* of Bridge); the opisthotic (*Jc.*); and the *occipitale laterale* (*Ol.*) spoken of above. The inferior view of the co-ossified occipital vertebræ is also to be seen from this side.

Upon a direct lateral view (Fig. 5) may be seen the premaxillary (*Pmx.*); the septo-maxillary (*Smx.*); the prefontal (*Prf.*); the orbito-

sphenoid (*os.*); the post-frontal (*Psf.*); the alisphenoid (*As.*); the prootic (*Pe.*); the epiotic (*Ex.*); the opisthotic (*Jc.*); the exoccipital (*Ol.*), and the lateral view of the co-ossified "occipital arches" of Sagemehl.

Lastly, viewing the cranium directly from behind (Pl. III, Fig. 13), we may see the opisthotic (*Jc.*); the exoccipital (*Ol.*); the epiotic (*Ex.*), and the rear view of the vertebræ that have co-ossified with the occiput. Should the vomers and parasphenoid be allowed to remain on, these may also be seen upon lateral views.

As the preceding paragraphs give the differences in nomenclature as used by Sagemehl and Bridge, it will be unnecessary for me to remark upon it further in this connection. I will simply say here that from this point on, I propose to adopt the terms employed by the latter author in designating the various bones.

The *vomers* are cleft behind to admit the parasphenoid, while they are united for their anterior thirds by suture.

Near its middle, the *parasphenoid* throws off on either side a lateral wing, which in each case passes upwards in a curve to bound the proötic anteriorly, lying between the foramina of exit for the fifth and seventh nerves, and finally terminates against the postfrontal.

Viewed from below, the united *premaxillæ* form a crescent-shaped bone, that supports a complete single row of sharp, incurved teeth. These are second in point of size of the various teeth found upon this part of the skull; the largest being on the palatines, and the smallest on the posterior margins of the maxillaries, that is if we do not take into consideration those minute teeth found on certain areas of the bones of the mouth. The ascending portion of the *premaxillæ* is carried back between the nasals and the sub-nasal cartilage as far as the frontals, being covered in this situation by the nasals and ethmoid. Each ascending process is pierced near its center by an oval foramen for the passage of the olfactory nerve.

We now come to examine the chondro-cranium proper and the ossifications that take place in it. Removing the bones we have just described, the remaining part, pyramidal in form, has its broad end posteriorly, while it terminates in front in the prenasal process. The cartilaginous vault is unpierced by any foramina, and neither prominent otic or nasal projections exist, as seen in many of the Teleostei. Accommodating itself to the form of the cranium, the brain-box passes between the orbits to have its apical anterior end terminate between the prefrontals against the hinder margin of the lamina perpendicularis, which in turn terminates anteriorly in the prenasal process, referred to above.

The *supraoccipital* is absent and the *basioccipital* is much elongated, owing to the fact that it has appropriated two of the leading vertebræ of the column, the neural arches of which ride it above.

Exoccipitals are well developed, and contribute both to the peripheries of the foramen magnum and the opening for the vagus.

Independent epiotic, opisthotic, sphenotic (postfrontal), and proötic osseous elements are represented in the auditory capsule, but the proötic is the only one that passes through the cranial wall to be discerned upon the inner aspect of the brain-case. The pterotics are absent.

By the proper interchange of the nomenclature, minute descriptions of all these elements are contained in Part I. Bridge's descriptions are also terse and clear. For those who may by chance in their reading wish to compare the investigations and studies of Bridge upon the cranium of Amia, in his article in the Journal of Anatomy, with Part I of this paper, the following table will be found to be useful in the connection, presenting as it does in a concise form a few of the differences interminology employed by these two authors; where the number of the figure is given in parentheses it is reproduced in this memoir.

TABLE.

Shufeldt.	Figures and lettering.	Bridge.	Sagemehl.
Ethmoid	Fig. 1 + (*Eth.*)	Ethmoid	Ethmoideum. (*Eth.*)
Nasal	Fig. 1 + (*Na.*)	Nasal	Nasale. (*Na.*)
Septomaxillary	Fig. 3 + (*Smx.*)	Septomaxillary	Septomaxillare. (*Smx.*)
Premaxillary	Fig. 2 + (*Pmx.*)	Premaxilla	Praemaxillare. (*Pmx.*)
Preorbital	Fig. 1 (*An.*)	Preorbital	Antorbitale. (*An.*)
Prefrontal	Fig. 3 + (*Prf.*)	Prefrontal	Præfrontale. (*Prf.*)
Frontal	Fig. 16 + (*F.* or *Fr.*)	Frontal	Frontale. (*F.*)
Postfrontal	Fig. 3 + (*Psf.*)	Postfrontal (sphenotic)	Postfrontale. (*Psf.*)
Parietal	Fig. 1 + (*Pa.*)	Dermo-supraoccipital	Parietale. (*Pa.*)
Squamosal	Fig. 1 + (*Sq.*)	Parietal	Squamosum. (*Sq.*)
Supratemporal	Figs. 1, 16 + (*S. t. p.* and *Esc*)	Supratemporal	Extrascapula. (*Exc.*)
Posttemporal	Fig. 1, 16 + (*Sc.* or *Pst. T.*)	Posttemporal	Suprascapula. (*Sc.*)
Exoccipital	Fig. 1 + (*Ol*)	Exoccipital	Occipitale laterale. (*Ol.*)
Basioccipital	Fig. 5 + (*Ob.*)		Occipitale basilare. (*Ob.*)
Epiotic (*Ep. o*)	Fig. 5 + (*Ex.*)	Epiotic (*Ep. o*)	Occipitale externum. (*Ex.*)
Proötic (*Pr. o*)	Fig. 5 + (*Pe.*)	Proötic	Petrosum. (*Pe.*)
Pterotic (absent)		Absent	Absent.
Opisthotic (*Op. o*)	Fig. 3 + (*Jc.*)	Opisthotic	Intercalare. (*Jc.*)
Vomer	Fig. 2 + (*Vo.*)	Vomer	Vomer. (*Vo.*)
Parasphenoid	Fig. 2 + (*Ps.*)	Parasphenoid	Parasphenoid. (*Ps.*)
Orbitosphenoid	Fig. 2 + (*Os.*)	Orbitosphenoid	Orbitosphenoid. (*Os.*)
Alisphenoid	Fig. 2 + (*As.*)	Alisphenoid	Alisphenoid. (*As.*)

A + means other figures than the one quoted in the second column show the same bone similarly lettered.

The mucus canals have been so thoroughly treated in Part I that I will not revert to them again here. In the mandible the single ramal branch commences in the angular element to pass through the dentary for its entire length, to meet the fellow of the opposite side at the symphysis. This branch connects with the system of the rest of the skull, where the angular articulates with the preoperculum, through which latter bone the lateral mucus canal passes, after having traversed the supratemporal and squamosal.

Both the orbitosphenoids and alisphenoids are more or less circular bones. This is due to the fact that during their extension and development they have not proceeded sufficiently far as to impinge upon neighboring osseous elements for the major part of their peripheries. The position of these bones is well shown in Fig. 3, and others.

The alisphenoid develops two processes and is pierced by two foramina. Of the processes, the smaller one arches over the canal for the orbital muscles; the other is the "descending process of the alisphenoid." The larger foramen passes the first division of the fifth nerve; while the outer and smaller one transmits the second and third divisions.

In each orbitosphenoid we see a deep cleft to allow for the exit of the optic nerve from the brain-case. They are supported by the coalesced trabeculæ below, articulate with the alisphenoids laterally, and support the cover-bones above.

The eye-muscle canal; the shallow pituitary fossa; the trabecular groove; the anterior clinoid process or wall, with the ossifications in its substance; the "proötic bridge;" the openings of the carotid arteries; and other structures in this region have all been sufficiently dwelt upon in Part I.

The lamina perpendicularis being in cartilage, *Amia* in consequence lacks the true ethmoid found in *Polypterus*. In referring to the septomaxillaries Mr. Bridge says that "The two ossifications above referred to as forming the antero-lateral angles of the internasal area are peculiar to Amia amongst Ganoids. They lie, one on each side of the prenasal process, and appear to be ossifications in the cartilage of the floors of the nasal capsules; inferiorly they rest upon the upper surfaces of the vomers. There can, I think, be but little doubt that these ossicles (*sep. mx.*) [Fig. 3 and others of this paper *smx.*] are homologous with the paired endosteal ossifications, which are to be found at the distal end of the great prenasal rostrum in the Pike. In fact, if the prenasal region in Amia were produced anteriorly into a rostrum comparable to that of the Pike, these bones would exactly resemble in position and relations their homologues in the latter fish."

"These ossicles would also appear to be homologous with the septomaxillary bone described by Mr. Parker as existing in the flow of the nasal capsules in the Frog; and also with similar bones in the Ophidia. A section carried through these bones and adjacent cartilage in Amia would resemble in all essentials the various sections given in Mr. Parker's paper (Phil. Trans., 1871) on the development of the frog's skull (Pl. X)"

The next step in our dissection is to carefully remove the suborbital chain of bones; the maxillary and admaxillary; and the ganoid plates overlying the nasal and premaxillary regions, then we have exposed in the prepared skull the elements of the

PALATO-PTERYGOID ARCADE.

This is made up of the palatine, entopterygoid, ectopterygoid, with which are associated the metapterygoid, hyomandibular, symplectic, and quadrate. While intimately related to it is the preoperculum, and less so the operculum itself, which latter merely articulates with the hyomandibular. The entire arrangement of these bones in *Amia* is

upon the Teleostean type, and all the elements found in the bony fishes are present.

Mr. Bridge, in his figure (Jour. Anat., 1877, Fig. 6) representing what I here have drawn in my figure 19, has inserted cartilage among the palatine and the several pterygoid bones. This material I have failed to find in this situation in any specimen *of the age* represented in either figure that I have thus far examined.

The *palatine* (Pl. VI, Fig. 19, *Pl.*) is thoroughly well developed and armed with two sets or kinds of teeth; the first of these, and the largest in this part of the skull, form a single row upon the lateral or exosteal portion of the bone in continuation with those on the premaxillæ. Others, very much smaller, are arranged internal to these on the endosteal lamina of the palatine and continue the vomerine series. Anteriorly at its apex the palatine is grooved to receive the inturned process of the maxillary, which is here wedged in between this bone and the premaxillary. The palatine is also in relation in this region with the septomaxillary, vomer, and prefrontal. It possesses the unique character among Ganoids in its relation with the latter bone in being carried in front of its articulation, a condition well known to us among the bony fishes.

The *entopterygoid* forms the major share of the floor of the orbit, articulating by overlapping sutures with the bones it comes in contact with, while its entire buccal surface seems to be overspread with very minute teeth. This latter condition applies also to the *ectopterygoid* (Pl. VI, Fig. 19, *Enpt. Ectp.*), this bone being additionally armed with a row of fine teeth upon its lower border containing the palatine series. It connects the palatine and quadrate but is separated from the metapterygoid by a thin strip of the entopterygoid.

The *metapterygoid* (Fig. 19, *M. Pt.*) is shaped like a fan with its handle, tipped on the end with cartilage, directed upwards toward the orbit. This is the ascending process of the metapterygoid. The fan part terminates in an angle at either extremity; the anterior angle nearly touches the alisphenoid, while the posterior one overlaps the hyomandibular.

So close is the union between the *quadrate* and *symplectic*, that these two elements appear to form one bone. Taken together they are shaped somewhat like a spherical triangle, the lower angle of each being distinct, the symplectic terminating above the quadrate, each to bear an articular facet for the mandible. In the case of the quadrate this is convex and hemispherical, while in the companion bone it is crescentic and concave, being in reality, one-third of the socket of which the preoperculum affords the remaining two-thirds.

It requires severe maceration in order to separate the symplectic from the quadrate, the union almost amounting to true anchylosis.

The *hyomandibular* (Fig. 19, *H. M.*) is obliquely pierced by an elliptical foramen, near its centre for the exit of the facial nerve. Above,

its straight border articulates in an elongated facet in the cartilage over the otic region. Behind, it supports a large circular facet, borne upon a subsessile stem, for the operculum (*ro*).

Its relation with the cartilaginous interhyal and the symplectic agrees very closely with typical Teleosteans.

Bridge seems to be inclined to believe that the angle formed anteriorly by the long axes of hyomandibular and symplectic, which give these bones their directions, may account for the movement forward of the metapterygoid in this Ganoid. In most Teleosteans this latter bone is directly over the quadrate, and not in front of it. In this I cannot agree with him, but attribute the position of the metapterygoid in *Amia*, entirely to its unusual size, as compared with the neighboring bones, rendering it a physical impossibility to assume any other position. This bone in a bass (*Micropterus salmoides*) before me is squarely over the quadrate and rather behind it, whereas the anterior angle formed by the hyomandibular and symplectic is quite as acute as it is in *Amia*, but the quadrate is relatively very much smaller.

Of the hyoidean and branchial arches (Fig. 19).—In this connection I will also describe the extraordinary series of branchiostegal rays in *Amia*.[62] There are twelve of these appendages, articulating through ligamentous attachment, well within the posterior borders of the epihyal and ceratohyal, upon their outer surfaces. They diminish gradually in size from above downward, slightly overlapping each other about half way down the series. The superior and largest has a somewhat different form from the others, being a long ellipse, with a well-marked longitudinal groove close to its upper border on its external aspect. This surface likewise is sculptured all over quite as thoroughly as one of the ganoid plates and in a similar manner. It articulates both with the epihyal and ceratohyal. The sculpturing gradually disappears as we near the middle of the series, through it can be faintly discerned to the very anterior ray. In life, these rays lap each other anteriorly, the set from one side over the set from the other, under the throat, where they constitute a striking feature and unique ornament.

The articulation of the hyoid with the hyomandibular and symplectic, through the intervention of the cartilaginous interhyal with this bone and the epihyal is very similar to the state of affairs as we find it among ordinary teleostean fishes. Holding a mid-position in the arch, the ceratohyal is a strong, well developed bone, bent at an elbow near its middle (Fig. 19 *c. hy*). The arch is completed by the lumpy little hypohyal, borne at its anterior extremity (*H. hy*). No evidences exist of an ossified glosso-hyal.

The basibranchial elements of the branchial apparatus are composed chiefly of cartilage with very little bone; one of the number seems to be

[62] Mr. Bridge seems to have unfortunately secured an imperfect specimen of the mud-fish in this particular, as he affirms that there are but eleven of these rays, that is hardly a good reason, however, for figuring but *ten*.—(Jour. of Anat., July, 1877, p. 609, and Fig. 6, Plate IV.)

better ossified than the others. There are altogether four of them, and they are much compressed from side to side. The arches proper are five in number, the first four being complete, with the usual elements present. They are completely beset with groups of minute teeth, which ride them above, and come off like scales during maceration. The gill-rakers are very small and thick-set.

Mr. Bridge completes his article in the Journal of Anatomy by a very valuable and concise summary. As this occupies but little more than a page, and contains so much, and in such a convenient form, of use in the present connection, I feel quite sure the reader will think me warranted in reproducing it here, and no doubt be thankful for it.

This author says that "In summarizing the result of the foregoing description of the skull of Amia, I would lay stress on the following facts, as having a special bearing on the affinities of Amia to the more highly specialized osseous fishes and to the amphibia.

"I. The possession of a complete chondrocranium, *i. e.* the absence of fenestræ in the cranial roof, as in Lepidasteus and the Pike (Esox).

"II. The existence of a nearly complete series of otic bones, comprising a large pro-otic, with internal plates forming a characteristic "pro-otic bridge" in the floor of the cranium, opisthotic, epiotic, and sphenotic elements.

"III. The presence of two ossific centers, partly exosteal and in part endosteal, forming rudimentary basisphenoid.

"IV. Septo-maxillary ossifications in the subnasal lamina, as in Clarias, Esox, Rana, and Ophidia.

"V. The interorbital prolongation of the cranial cavity, separating distinct, paired ali- and orbitosphenoids.

"VI. The prolongation of the palatine in front of its prefrontal articulation, and the connection of its anterior end with the inwardly curved process of the maxilla.

"VII. The possession of a T-shaped dermal ethmoid overlying the *premaxillæ*, and the close analogy in number and relations between the investing ganoid plates of Amia and those of the Siluroidei, and especially with those of Clarias, as has been previously described.

"VIII. A complete series of opercular bones, a preoperculum anchylosed to the hyomandibular and symplectic bones, an operculum, an interoperculum, and a suboperculum.

"IX. The presence of a jugal bone [admaxillary (*a*)] attached as in Teleostei to the upper edge of the posterior part of the maxilla.

"X. The existence of a mento-meckelian ossicle, as in Spatularia, and of several additional centers of ossification in the proximal extremity of Meckel's cartilage.

"XI. The presence of five accessory dentigerous splenial elements in addition to the normal mandibular splints, as in the young Polypterus and Ceratodus among Ganoids, and in Siren and larval Salamanders among Amphibia.

"In continuing in its cranial structure the anatomical facts expressed in paragraphs I–IX inclusive, Amia differs from all other living Ganoidei, and exhibits distinct and decided affinities to such generalized types of *physostomus Teleostei* as the Siluroidei, Cyprinoidei, &c. On the other hand, in common with all other Ganoids, Amia possesses several points of resemblance with larval and adult forms of Amphibia, especially as regards the structure to which attention has been directed in paragraphs IV, X, and XI."

"Moreover, in the angulation of the mandibular arch, caused by the forward growth of its metapterygoid element, we have a repetition of an arrangement characteristic of the adult frog, and of certain Selachians, Notidanus. But notwithstanding these evidences of widespread affinity it is evident that if, in addition to the above-mentioned facts, we credit Amia with the possession of cycloid scales, non-lobate fins, a nearly homocercal tail, and note the absence of spiracles, the Teleostean affinities predominate; and it may be asked whether, despite certain peculiarities in structure of its generative organs and bulbous arteriosus, the gap between the ganoid Amia and the physostomus Teleostei is not less than need be expressed by ordinal distinction. It may be that just as Polypterus and its near ally of the same family are the sole surviving examples of the otherwise long extinct order of Crossopterygian Ganoids, so the Amiidæ are the sole survivors of those widely-generalized Ganoidei out of which more specialized Teleostei were directly evolved."

Now, if it were my intention to carry the comparative studies of the skeleton of Amia further than Dr. Sagemehl has in Part I, I would enter the tempting fields offered by the minute examinations that could be made of other American Ganoids and compare them in every particular with our subject. Then comparisons made with the complete skeletons of *Elops* and *Megalops* would be particularly interesting, and on some future occasions these may be treated as I have endeavored to treat *Amia* in this paper. But to undertake such comparisons here would lead me far beyond the intention and scope of my original plan.

It does, however, fall within the limits of this plan to present here a concise review of the skull and other parts of the skeleton of a well-specialized Teleostean, more particularly the skull. Such a review, it is hoped, with its illustrations and figures, will be valuable, from a comparative point of view, taken in the present connection, as well as forming a groundwork for future studies or the observations of others entering upon the study of the anatomy of fishes for the first time.

Of a Teleostean skull.—For my review of this part of the skeleton of a Teleost and for references to such other parts of the osseous system as I propose to enter upon, I have chosen a specimen of *Micropterus salmoides.* This was done because the large-mouthed black bass is a fish of pretty general distribution in the United States, and consequently

will be more easily available for those who wish to compare my statements with the specimen of the fish before them.

In the adult *Micropterus* we find the entire skull very thoroughly ossified, with the vast majority of the bony elements pertaining to this part of the Telesotean skeleton present. Viewing the *cranium* from above, we have presented us for examination, on its hinder calf, five prominent crests; two on either side and a median one. This latter appears to be developed entirely by the supraoccipital (Plate XI, Fig. 27, *S. O*). If the free margins of the lateral crests were produced anteriorly they would all meet at a point just beyond the supraethmoid. The inner pair of these crests are developed by the parietals (Fig. 27, *Pa.*), and they terminate posteriorly in horizontally flattened processes formed by the *epiotics* (*Ep. O*). On the outer side the crests are formed by the squamosals, which in their turn are completed behind by the *pterotics*, which here are vertically compressed plates (Fig. 27, *Sq. Pt. O*). The crest part of the squamosal is formed of two lamina, between which passes the squamosal mucus canal. A deep sulcus is found between the hinder ends of the parietal and squamosal crests, at the base of which we find a large triangular foramen, covered over in the recent state by membrane, just beyond the squamosal, on either side the crescent-shaped and upper part of the *postfrontal* (*Pt. f*). The mid-region of this aspect of the cranium, and constituting the vault of the orbits, is formed by the broad *frontals* (*Fr.*) with a tolerably distinct suture still visible between them. Here an interesting condition of the mucus canals presents itself. This consists in a large V-shaped covered canal with its convex arc just beyond the crest of the supraoccipital, where it has in the median line a common opening. The limbs of this covered V pass through each frontal, to open on the surface, in elliptical apertures, a little behind the prefrontals. They then tunnel again to open once more directly forward on either side of the supraethmoid and over the surface of the nasals. From our superior aspect we also have a good view of the upper surface of the sculptured prefrontals (Fig. 27, *Prf.*), forming the anterior walls of the orbits. Beyond this the region is occupied by the supraethmoid and upper part of the vomer. It is pierced on either side of the promontory formed by the supraethmoid, by the nasal foramen, and the opening for the olfactory nerve.

Upon a lateral view of the cranium we are to note the deep articular facet for the hyomandibular extending from the postfrontal along below the squamosal crest, and occupying the lateral portion of this bone.

Here we see, also, that the *postfrontals* dip pretty well down on the lateral wall, wedging in between the alisphenoid and proötic (Fig. 27, *As. Pr. O. and Ptf.*). The *opisthotics* occupy their most usual site in front of the exoccipital on either side. Beyond the alisphenoid I find an ossification I take to be the *orbitosphenoid*, it is in contact with the alisphenoid behind, runs down the lateral wall of the cranial cavity, while it forms a prominent ridge traversing forwards on the under side

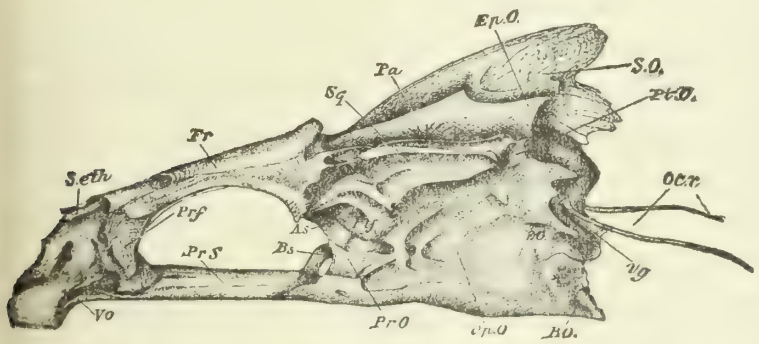
of the frontal. Above each one we observe a canal for the passage of the olfactory nerve from the brain-case to the nasal capsule. The exit for the trigeminal nerve is bridged across by a thin lamina of bone, apparently afforded by the proötic. Another and smaller osseous bridge is found immediately to the rear of this first one. Upon this view the suture between the ex- and basioccipital is plainly visible, while a deep concavity exists in the region through which it is directed.

The *parasphenoid* (Fig. 27, *Pr. S.*), prefrontal, and vomer may also be studied from a lateral view, and the *basisphenoid* is likewise brought into sight. (*B. S.*)

A rear view of the cranium presents most conspicuously among its points for examination the circular and conically concave facet for articulation with the centrum of the atlas. It is developed by the basioccipital and somewhat lower in position than the horizontal plane of the parasphenoid. Above it are two elliptical facets, directed downwards, backwards, and inwards, for articulation with similar surfaces on the first verterbra. Between these exoccipital facets and yet well above them is the foramen magnum, a heart-shaped opening looking downward and backward. The suture dividing the exoccipitals is plainly visible in the median plane of its inferior circumference.

Just above the exoccipital facet, on either side, we find the vagus foramen for the exit of that nerve. Anterior, and at the same time internal to these openings, is to be found a shallow facet, one on each side. These are for the heads of a pair of *occipital ribs* that articulate at these points, and which I have elsewhere described.[63]

The exoccipitals meet just above the foramen magnum, at which point they receive between them the thin lamelliform crest of the supraocci-



Left lateral view of cranium of *Micropterus salmoides*, showing occipital ribs, *Oc. r.* Half size of the original specimen; from author's drawing published in Science (No. 65.) *S. eth*, supraethmoid: *vg.* vagus foramen; and the other lettering the same as figures in this paper.

[63] Shufeldt, R. W. "Osteology of the large-mouthed Black Bass." *Science*, No. 65. Cambridge, May 2, 1884, p. 532. These ribs are of so much interest and at the same time so much importance from a morphological point of view, that I feel warranted in reproducing my original figure of them in this foot-note, illustrating what I have said above in the text. As already announced in *Science*, I have since detected them in the Tunny (*O. Thynnus*) and suspect their occurrence in some of the Scombridæ. It will be interesting for those now engaged in dissecting fishes, or others investigating the anatomy of the class, to be on the lookout for these structures. The family Centrarchidæ should receive particular attention in this regard, and of these the genus *Lepomis* stands among the first to be suspected. Their exact location and constancy should be noted.

pital. The body of this latter bone makes up the major portion of the quadrate surface, upon this aspect of the cranium, contained between the spur-like epiotics and the facets of the exoccipitals. Beyond this surface the pterotics project on either side, in about the same horizontal plane with the superior circumference of the foramen magnum.

An inferior view of the cranium presents principally for our inspection the two bones, *parasphenoid* and *vomer* (Fig. 27, *Pr. S.* vomer not in sight). These, as we well know, are in the adult bass, azygos bones lying in the median plane. The *parasphenoid*, by the assistance of the basioccipital, forms a large oval-shaped surface beneath the canal for the eye muscles; it then contracts again, at which contraction it throws up on either side a plate-like process that has been nearly entirely absorbed by the proötic. The bone beyond this shows another dilation, but not as large as the rear one. It then contracts to form the solid bar that lies between and beneath the orbits (Fig. 27, *Pr. S.*), which anteriorly runs above the vomer and under the prefrontals.

The *vomer* of Micropterus is a very prominent bone. It is carried back well on the under surface of the parasphenoid in a pointed process, the suture between the two bones being easily distinguishable, although this part of the vomer in other respects appears like an extension of the parasphenoid. Anteriorly it forms a beak which is rounded in front, carried well below the general surface beneath, the inferior aspect of this latter part being semicircular in outline and thickly studded with fine teeth.

Of a few of the general points to be noticed about the cranium of *Micropterus*, we have the raised pedicle on the line extending from the prefrontal to the vomer. This pedicle supports an articular facet, directed downwards and forwards, for articulation with a rounded and elevated facet on the anterior end of the maxillary. The bone I have called *supraethmoid* in Fig. 27 is so termed by Parker in his Salmon's skull, because it overlies the cartilaginous ethmoid in that fish; the element is, however, generally termed the ethmoid, or the medium ethmoid (Gegenbaur), and I feel myself at liberty to apply either name to it. The ethmoid is a very proper one. In this bass the proötics form the antero-lateral walls of the eye-muscle canal, but do not meet below in the median line, as they do in some of the Teleostei. Between them in the median line, and springing from the floor of the brain-case, we find a delicate arch of bone, with its convexity directed forwards, that comes down to meet the parasphenoid. This arch belongs to the basisphenoid (Fig. 27, *B. S.*) and is found in many of the bony fishes.

As the relations of many of these bones, described above, on the inner cranial wall, show very well in a vertical, longitudinal section of the cranium of our common American perch (*Perca americana*), I figure such a section here in preference to Micropterus, where the bounding lines or sutures among the elements are not so evident or easily studied.

Some of these cranial bones may be considered to form certain groups, of which *four* enter into the *occipital region*. These are the basioccipital, the two exoccipitals, and the supraoccipital. In *Micropterus*, as in all fishes, the basioccipital is the direct continuation of the spinal column, and possesses many of the characters pertaining to the vertebræ. The *exoccipitals* inclose the aperture of the foramen magnum entirely in this fish, only partly in many others. The supraoccipital, or the upper segment, supports a median crest that corresponds to the neural spine of the vertebra. Its form varies exceedingly, as well as its size. Another group of bones inclose the ear capsule, and have had names bestowed upon them that denote the relative position they bear to it. First and most constant among these is the *proötic;* it is either pierced by or limits the foramen for the trigeminal nerve. Second in order come the *epiotic*, which overlies the superior vertical semicircular canal. It, in the vast majority of fishes, always forms a projecting process. Next we have the *opisthotic*, a segment lying in front and to the side of the exoccipital, but does not appear on the internal aspect of the brain-case nor bear any direct relation with the labyrinth. To these three bones Mr. Parker added a fourth, the *pterotic*, which in fishes forms the postero-external angle of the cranium. In most bony fishes it articulates with the outer limit of the posttemporal. I may add here, in passing, that these bones form the "periotic mass," and are the same found in the petro-mastoid portion of the temporal in man and the other higher vertebrates. It is unnecessary to say more than I already have above about the *squamosal* and *postfrontal*. The latter is sometimes termed the sphenotic, and assists often the former in the formation of the articular facet for the hyomandibular. This is the case in *Micropterus.*

Beyond these, in another group, we have the alisphenoid at the sides and behind and the orbitosphenoids anterior to them, while the basisphenoid is found below. This latter bone, we have already shown in the black bass, forms an osseous partition between the two sets of orbital muscles; it may be absent in some of the Teleostei and very small in others.

On the cranial vault the parietals are not always separated from each other by the intervention of the supraoccipital as they are in *Micropterus*, nor are the frontals always separate bones, they sometimes forming only a single piece, as in *Gadus*. The segments of the ethmoidal region have been sufficiently described above. They all, the prefrontals, ethmoid, and vomer, vary greatly in size, form, and relationship throughout the class.

To still further illustrate the relations that may exist among the bones in crania of osseous fishes, as well as some of the remarkable forms they may assume, I am indebted to Professor Gill for the loan from his private cabinet of the cranium and portion of the palato-quadrate arch of a specimen of *Albula vulpes* and an imperfect cranium of *Megalops*, the latter

being the only one he had in his possession. I chose these two crania, from which I made the drawings that illustrate this essay, because we find in the organization of both *Albula* and *Megalops* at least one feature that they possess in common with *Amia*. In *Albula* it is the peculiar structure of the *bulbus arteriosus* and in *Megalops* the presence of the gular plate. But in describing the crania of these two forms I will confine myself strictly to the two specimens in question, and only describe what is to be seen in them. The sequel will prove that there is much of interest and importance. Judging from the cranium alone, the complete dissection of *Albula* will well repay the anatomist some day, for this part of its skeleton presents many points of the greatest interest and diversity in development.

There is but this one species of *Albula* known to science, and its principal habitat are the warm tropical seas, where it is abundant. With us, however, it has been taken from Cape Cod clear around to Southern California (Jordan and Gilbert.) This fish, we are told by the authors just quoted, possesses "no gular plate."

Viewing the cranium of *Albula* from above, and proceeding with our examination from before, backwards, the first object that strikes us is the extraordinary ethmoid it possesses. (Plate XII, Fig. 30, *Eth.*)

This bone is fashioned off in front so as to remind one very much of the snout of a pig. From this part it extends backwards in a median crest, deeply grooved above. This runs in between two prolongations developed by the frontals, and can be seen opposite the letters Na^2 in Fig. 29. Anteriorly the ethmoid projects over the parasphenoid, which bone abuts against it. From the base of its median crest it sends downwards and outwards on either side a plate-like portion, the margins of which curl up for their posterior moiety. A vacuity of an elliptical outline exists in the crest anteriorly as it reaches the snout-like protuberence, and only the grooved part is carried over to meet this portion of the bone. This foramen can only be seen upon a lateral view as shown in this figure.

The frontals (Plate XIII, Fig. 30, *Fr.*) are very extensive bones and cover nearly the entire superior aspect of the cranium. Their union with the ethmoid is of such a nature as at first to give one the impression that the two are but one bone, and indeed the suture between them is not always discovered at once. Just above the prefrontals, bones which they overshadow all to their outstanding wings, they present on either side of the extension of the ethmoidal crest the openings of two very large mucus canals. These open behind in slit-like foramina, just beyond the letters *Fr.* (Fig. 30), as well as in more minute openings behind and to the outer side of them. The frontals completely overarch the orbits, lap down upon the postfrontals and squamosals, while posteriorly in this specimen the left-hand bone appears to overlie the fellow of the opposite side as well as both the parietals. These latter bones are comparatively small plates of a quadrilateral outline,

with the supraoccipital wedged in between them from behind. The squamosals present quite an extensive surface on superior aspect, and they too have running through them longitudinally, with anterior and posterior apertures, capacious mucus canals. These apertures can be well seen in Fig. 30, the hinder elliptical one just below the letters *Sq.*, and the anterior one opening out over the surface of the prefrontal. (*Ptf.*)

A certain amount of sculpturing is seen upon the surface of the frontals, parietals, and squamosals, in the form of a decided radiation from a central point. This is most perfectly marked in the frontals, where fine radiating lines are carried clear to the peripheries of these bones. A longitudinal depression is found between these latter segments in *Albula*, of a triangular form, being narrow and deep anteriorly, shallow and broad behind. The epiotic and supraoccipital we will reserve for description until we come to deal with the posterior aspect of the cranium of this fish. Fig. 30 shows very well indeed the extent to which these bones may be seen from a superior view of this part of the skull.

The inferior view (Plate XIII, Fig. 31) of the cranium of *Albula* is even more interesting than the superior, owing to the numerous points presented for our examination. This view shows us how far the ethmoid overhangs the parasphenoid, for the narrow, little transverse suture between these two bones is distinctly visible. Just beyond it, on the former bone, we observe a globular protuberance, deeply cleft by a transverse facet, which I take to be the articulation for the upper jaw. Behind this ethmo-parasphenoidal suture the vomer is seen. This bone is shaped like a little fan, the handle being directed backwards in the median line, while the expanded portion lies in the horizontal plane with a rounded margin anteriorly. Within this we find a double row of sockets in the specimen evidently intended for a series of minute teeth. Posterior to the vomerine region the parasphenoid presents a considerable excavation mesially, while opposite this the bone develops, on either side, a horizontal wing-like lamina. Each wing is raised above the general inferior surface of the parasphenoid, being between that bone and the prefrontal behind, while anteriorly it merges into it again. Outside they are bounded by a sharp margin, gently convex throughout.

This aspect also reveals to us again a partial view of the prefrontals (Fig. 31, *Prf.*) with their postero-alar projections. The central point of interest, however, centers about the paraspheroid in this region. It is here broad and elliptical, concave from before backwards, and slightly so from side to side. An area of teeth occupy this space, conforming to its shape, though separated from its limiting margins all about by some two or three millimeters. These teeth are of various sizes, the smaller ones being arranged all the way round, externally, while they become larger and larger as we approach the mid parts of the space. They are beautifully enameled and rounded. Where the large ones, however, are

crowded together centrally, they assume hexagonal or perhaps pentagonal forms. When they drop out and are lost, they leave quite a deep, conical pit or socket behind them. Posterior to this dental area, the parasphenoid lies horizontally, being convex from side to side, in order to conform with the lower surface of the cranium. Behind, it is forked, the limbs being carried backward to within a millimeter or so of the posterior margin of the basioccipital. Between them we find a triangular depression with its apex directed forward. Viewing the cranium from this aspect, its posterior third is broad and of a quadrilateral outline, the figure being bounded in front by the postfrontals (Fig. 31, *Ptf.*); laterally by the squamosals, and behind by the ex- and basioccipital, opisthotics, and squamosals. Rising in the center of this space, mesially, is the portion formed principally by the proötics and basioccipital, being overlapped by the parasphenoid. This contains the eye-muscle canal, with the braincase above it. Its form is well shown in the figures I present of the lateral and inferior views of the cranium of this fish. On either side of it occurs a deep conical indentation, about which the various foramina pierce the bone to enter the brain-case. These openings, and this great, blind, conical pit are bounded externally by the facet, on either side, for the hyomandibular.

The rear view of the cranium of *Abula* is an exceedingly interesting study, presenting conditions that I have never observed in any other fish. On the superior aspect of the cranium (Fig. 30 *S. O.*) we saw how the supraoccipital was wedged in between the parietals. From this portion in the middle line, it throws backwards and downwards a stumpy, triangular crest, composed for its greater part of two parallel and vertical laminæ, separated from each other by about a millimeter. On either side of this the bone extends horizontally for a little distance to meet the epiotics. These last elements may also be seen upon superior view (Fig. 30 *Ep. O.*). They there articulate with the squamosals and parietals, and with the supraoccipital as just described. Each epiotic from this position, is extended backwards as a stout horizontal and triangular process, a peculiar tubercle being developed on its superior surface. Beneath, and anteriorly, the under surface of this process sends down a vertical plate, lying parallel to the median plane. These two plates inclose a general concavity on the posterior aspect of the cranium, which is partially divided in two by a vertical crest on the supraoccipital which again is directly continued by the crest formed through the uniting suture of the exoccipitals. The upper part of the base of this concavity is composed of the vertical portion of the supra occipital, while all the lower part is composed of the broad exoccipitals, the cranium being held and viewed with the frontals upwards and in the horizontal plane. Now, wedged in, in this concavity, on each side, and outwards, we observe what first appears to be a separate and nearly circular piece of bone, it being pierced by three foraminæ. Towards the median line it articulates with the supraoccipital and exoccipital.

while externally it meets the epiotic. Careful examination shows that this plate belongs to the *squamosal*. At the base of each vertical epiotic plate is to be seen a stumpy process, formed by a separate segment of bone, which I take to be the *opisthotic*. It articulates with the epiotic, exoccipital, and squamosal. On the outer side of each vertical epiotic plate there is another very deep concavity formed entirely by the squamosal, except such inner part of its entrance which is entered into by the vertical epiotic plate just mentioned. It is near the opening of this deep pit (1.25 ^{cm}) on the inner hand that we have the opportunity to study the manner in which the squamosal furnishes the little circular plate that appears superficially in the larger concavity, as described above.

The *foramen magnum* is of a cordate outline, with its base below. It is directed, that is the plane tangent to its margins, somewhat downwards as well as backwards. Its boundary below is formed by the upper surface of the basioccipital condyle, while its lateral margins and apex are furnished by a bone shaped like a little saddle, which straddles the exoccipitals (Fig. 29, *c. v*). This bone, but loosely united along its median line above, articulates with these last-mentioned segments throughout its entire anterior margin, and in the specimen in my hand is slightly movable. At its lower and outer angles are seen a minute pair, one on either side, of postzygapophyses. This bone fails to come in contact with the basioccipital, and were it removed the foramen magnum would then be formed entirely by the basioccipital and exoccipitals, though these latter would be without articular zygapophysial facets for the first vertebra of the trunk. Dr. Gill expresses the opinion, in which I concur, that this double bonelet is the neural arch of the first vertebra of the column. This being the case, it is important to compare it with the co-ossified vertebræ found in this situation in Amia. I would not care to do this, however, until in possession of a recent specimen of *Albula* as well as its young. The outline of the basioccipital condyle is pentagonal, and it is deeply and conically concave. A large elliptical foramen pierces the supraoccipital on either side beneath, at the angle of its horizontal and vertical portion. Two small foramina are also found on either side in the exoccipitals just before we arrive at the suture, where they join the aforesaid free neural arch just mentioned.

This completes my description of the posterior view of the cranium of *Albula*, as far as I mean to carry it. I am well aware that these bones may be differently construed, but the moment we do so it becomes necessary to have the various segments articulate among each other in a manner differing from the general rule they adhere to in the vast majority of cases among teleosts. To satisfy himself of this fact the reader has but to call the bone I have described as a neural arch of the first vertebra, the united exoccipitals, and the result will soon be evident. We must remember, in this connection, that the facet for the

atlas, supplied by the occiput in *Amia*, is upon a co-ossified vertebra. (See Part I.)

Nearly all objects in nature are best seen, studied, and appreciated in direct lateral view, and to this aphorism the cranium of a fish offers no exception. This will at once be recognized in the case of our present subject the "Lady fish," a side view of the parts already examined, which I have endeavored to execute with great care, being presented in Fig. 29, along with the greater portion of the palato-quadrate arch. The shape of the curiously formed *ethmoid* (*Eth.*) is now easily seen, and its relations with its neighboring bones better understood; while beneath it the *vomer* shows but slightly, though enough of it can be observed in order to expose the position of the series of minute teeth spoken of above. The *prefrontal* is seen to be enormously developed. It meets its fellow in the median plane, each one being pierced near this region by a large elliptical foramen. Between the anterior convex border of this bone and the ethmoid we find a vertical lamina of bone articulating as shown in Fig. 29 at Na^2. This element I take to be merely a plate of semi-ossified cartilage, though an examination of *Albula* in the flesh, on some future occasion, may force me to a change of opinion. The true *nasals* in the specimen must have been lost. The orbits are seen to be almost completely separated from each other by a thoroughly ossified inter-orbital septum, an extension forward of the co-ossified *orbitosphenoids.* (Fig. 29 *Os.*) This septum is very materially added to by the broad, vertical plate, afforded by the *basisphenoid* (*ib. B. S.*)

This bone also sends upwards and outwards an osseous limb to articulate with the *alisphenoid* (*As.*). The three sphenoidal bones mentioned surround the optic foramen, as shown in the figure. While the prefrontal completely forms the anterior wall of the orbital cavity, the frontal the vault, the parasphenoid the floor, we find, in addition to the bones we have mentioned, that the posterior wall is largely formed by the *postfrontal* and *proötic.* Altogether this cavity is a very thoroughly circumscribed one, so far as its osseous boundaries are concerned.

The posterior aspect of the postfrontal (sphenotic) assists the squamosal in forming an extraordinarily deep pit in the region to the rear of the upper and posterior angle of the orbit. This pit is bounded above by the squamosal and frontal, anteriorly by the alisphenoid and postfrontal, internally by the squamosal, which bone with the postfrontal forms its floor; behind, it opens along a longitudinal concavity of the squamosal. Immediately below this concavity we find the facet for articulation with the hyomandibular, also formed by the squamosal in part, its anterior moiety being constituted by the postfrontal—not an uncommon condition among the Teleostei.

The regions occupied by the basi- and exoccipital, the proötic and other bones, are so well shown in the figure as not to need any special description here.

We are still further impressed with the marked departures from the ordinary fishes made by *Albula* in its skull when we come to examine such of the bones of the palatoquadrate arch as I have before me, for which I am also indebted to Professor Gill. One view of this arch I have drawn in connection with the lateral view of the cranium (Fig. 29); the other is an inner view of the same specimen, and awarded a separate figure (Fig. 28). When this arch is snugly articulated with the cranium, the *hyomandibular* (*H. M.*) is nearly in contact with the postfrontal and proötic for its entire length, or rather as much of it as is opposite these bones; the same may be said for the remaining elements, the metapterygoidal and entopterygoidal margins meeting the opposed margin of the parasphenoid. Upon an inner aspect this brings the area of teeth found upon the entopterygoid (Fig. 28) opposite and at right angles with the similarly constituted teeth upon the parasphenoid. That teeth should occur exclusively upon the first-mentioned segment is a remarkable fact of itself and worthy of special note. Particular attention is invited to the *symplectic* (*Sym.*) of *Albula*, shown in these drawings, holding as it does a most unique position. Indeed, this may be said of all the bones in this arch; the *metapterygoid* is thrown clear to the rear of the *quadrate*, while in *Amia* it reaches well beyond that bone. Both the *entopterygoid* and *ectopterygoid* are enormously developed. Wedged in between them posteriorly and above is a large mass of bone that appears to be developed on the part of the first mentioned element. Where they meet at the apex anteriorly I find another irregular piece of bone, with a little process on its outer side. This element appears to be separately ossified, but without a complete skull I could not say positively whether it be the *palatine* or not. It occupies about the proper position for that bone, and, everything considered, it would not surprise me to find it assuming any remarkable shape. A highly developed and prominent semiglobular facet is found on the upper third of the posterior margin of the hyomandibular, for articulation with the operculum.

Of the cranium of Megalops.—The specimen of the cranium of this fish is also from the cabinet of Professor Gill, and from it I have made two drawings (Plate XIV, Figs. 33 and 34)—a direct lateral view and a posterior one. The specimen is evidently not a perfect one, though it is the best I could secure for the purpose, and my reasons for choosing it have already been stated above. In this particular specimen the basisphenoid is apparently missing, its median plate having been broken off, leaving the points of fracture distinctly visible. Again, either a single parietal plate or a pair of parietals have undoubtedly been lost, and when perfect individuals come to be examined I believe the space existing in Fig. 34 between the supraoccipital and frontals will be properly filled in by such a plate or plates. The rear view of this cranium is unaffected by these losses, as none of the bones mentioned would come in sight in this aspect.

In *Megalops* the *vomer* is the most anterior bone of the cranium. Viewed from above, it presents a median crest with sloping sides, and is overlapped by a triangular process of the ethmoid. Below it is a broad semicircular plate, with a sharp spine directed backwards, which is mortised into the parasphenoid. Anteriorly this plate supports a raised elliptical disk, armed over its entire surface with exceedingly minute teeth (Fig. 34, *Vo.*). The *ethmoid* throws out on either side a curved and flattened process, directed outwards, downwards, and backwards; against the extremity of each rests an irregular prefrontal (Fig. 34, *Prf. Eth.*). This region is completed by the anterior extremities of the frontal and parasphenoid as far as its bony walls are concerned, while its remaining parts are fashioned in cartilage. The rostrum of the *parasphenoid* makes an angle of 45° with the plane of its body. Its anterior extremity is dilated from side to side, and articulates with the vomer, as already described. The under surface of the rostrum is longitudinally concave, deepest near its middle third. Its upper surface is composed of two sides, each directed upwards and outwards; they meet for the entire length in the median line. The lower part, or body, of the parasphenoid is scooped out above to assist in the formation of the eye-muscle canal; its outer margins articulating with the proötics (Fig. 34, *Pro.*). Posteriorly the parasphenoid is sharply forked, but is not carried backwards quite as far as the basioccipital goes.

The frontals (*Fr.*) are separated bones, divided by a median, and in the specimen rather an open, suture. Behind they overlap the squamosals on either side, while in turn they are beneath the hinder margin of the ethmoid in front. Their posterior margins are scalloped and the superficies of the bones above strongly sculptured. Either *postfrontal* develops a prominent lateral process; the extensive base supporting it so expands as to articulate with the squamosal and frontal above the alisphenoid internally and the proötic below. It also assists the squamosal in forming the anterior end of the hyomandibular facet (Fig. 34, *Ptf.*). A median tubular foramen passes longitudinally through the *orbitosphenoid*, below which it sends forward a peculiar little process as shown in the figure. This is carried backwards as a bony division, separating the alisphenoid, and forming the apex of the margin of the optic foramen. The body of the orbitosphenoid articulates with a cartilaginous plate anteriorly, while its sides, which are tipped upwards, inclose a space which we will devote our attention to further on. The *alisphenoids* are large circular bones, separated from each other by the orbitosphenoid in the median line. They bound the optic foramen laterally and form the posterior wall for the orbits. There seems to be every indication that in life they are separated above from the frontals by cartilage, though they articulate by suture with the postfrontals and proötics (Fig. 34, *As.*).

The *squamosal* is a very large and prominent bone in the cranium of this fish. Above, it forms a considerable share of the vault of the skull,

articulating with the epiotic behind, and the frontal and sphenotic in front. (*Sq.*) Laterally it forms the hyomandibular facet, and enters with the opisthotic and proötic into the formation of a deep conical indentation, immediately below the facet in question. It has a strongly marked and raised ridge, extending from its outer and posterior angle obliquely to the corresponding angle of the frontal (Fig. 34).

The *basioccipital* occupying its usual position, is much compressed from side to side, notwithstanding its centrum behind is very large, with raised periphery. Most of the antero-lateral region of the cranium of *Megalops* is made up of the *proötic* (*Pr. O.*). This bone is pierced by its usual foramina, and meets its fellow of the opposite side in the floor of the cranium. Upon the lateral view of this part of the skull, the most striking feature is a thin lamina of bone, with its plane nearly parallel with the basioccipital, and formed not altogether unlike a diminutive hand. This appendage seems to be developed on the part of the *opisthotic*, but of its function I can say nothing until I am permitted to make a dissection of a fresh specimen of *Megalops*. A *posterior view* of the cranium of this fish reveals to us its most extraordinary structure, and one that would not be suspected hardly from a direct lateral aspect; indeed, not at all, if the vacuity were filled in, where I believe the parietals really belong.

To arrive at a good description of the condition of affairs, as I find them here, it will be necessary for me to describe one or two of the bones seen on posterior view, and first among these the *supraoccipital*. Viewed from above, this bone presents somewhat of an extensive surface, being greatly convex from side to side, while it is carried forward in the median line as a sharp process (Fig. 34, *S. O.*), and behind we see developed a stunted, lamelliform "supraoccipital crest," extending directly backwards, with a small foramen on either side of it. Behind, this bone is represented by a vertical plate wedged in between the epiotics, a vacuity existing at its apex below. The *epiotics* are well shown in Fig. 33 (*Ep. O.*), and the manner in which they articulate with the exoccipitals and squamosals (*E. O.* and *Sq.*). Now upon the anterior aspect the supraoccipital and the epiotic on either side, chiefly the former bone, go to form a plowshare-shaped projection, that forms the hinder and upper part of the vault of the cranium. Beyond it lies a convex surface, in the specimen formed of dried membrane; this constitutes the next section of the *cranial vault*. Upon the outer side of either epiotic we observe a large elliptical opening; these lead into a capacious cavity that exists between the frontals, squamosals, and other bones of the roof above, and the true outer cranial vault, composed of the alisphenoids, prefrontals, squamosals, and other bones below. This cavity is irregularly wedge-shaped, its base being behind and its thin edge situated anteriorly. This latter part lies between the orbitosphenoids below and the frontals above. As we proceed backwards the interspace becomes greater, and it is here bounded by the

frontals above and the alisphenoid and postfrontals below. In this region, too, in the median line, we find that the alisphenoids and orbitosphenoids contribute to form a bony stanchion, that is directed forwards and upwards for the support of the frontal plates which rest upon its apex. The alisphenoids are produced clear backwards to form a dome-like surface, convex outwards, that is the anterior roof of the cranial vault. In this the alisphenoids are assisted by the postfrontals on either side, and both of these bones can be seen through the apertures of this cavity behind (Fig. 33, *As.* and *Ptf.*). The sides of the roof of the cranium are formed by an incurved surface on the part of each squamosal, while a somewhat similar surface, afforded by either exoccipital, completes the parietes of the brain case in the rear.

The form of the *exoccipitals*, the method in which they articulate with the surrounding bones, and how they contribute to the formation of the foramen magnum, is all well shown in Fig. 33, where these bones are marked *E. O.* A vagus foramen pierces each one on either side of the foramen magnum, while, owing to the fact that the exit for the optic nerves being so large, the parasphenoid can easily be discerned through the latter opening (Fig. 33). The basioccipital forms the lower arc of the periphery of the foramen magnum, as shown in the figure. Its large articular facet is completely covered, through the very interesting fact that it is so far anchylosed with the first vertebra of the column that it is impossible to remove the latter in the specimen without doing it injury (see Plate XIX, Figs. 33 and 34, *c. v.*). This is particularly interesting when we recall what has been said above, in regard to the co-ossified vertebra of *Amia*, found in this locality, as well as the suspicious condition of affairs in these parts in *Albula vulpes*. The suture between this vertebra in *Megalops* and the exoccipital is distinctly retained, and may be traced completely around the bone. Upon the upper side of this co-ossified or rather co-anchylosed vertebra are seen two circular pits, of some little depth and size. Dr. Gill states that these are intended to lodge the extremities of the neural arch. They are placed side by side transversely and about a millimeter apart. Two similar pits and similarly situated occur on the under side of the vertebra. I am unable to pronounce upon these without first examining a recent specimen of this fish.

Far as *Megalops* is removed from *Amia calva*, I still find in this old imperfect cranium from Professor Gill's cabinet plenty of food for thought—with its suspicious-looking basioccipital vertebra, with its appropriation of at least one trunk vertebra, with its *sculptured* frontals and other bones raised above the cranium proper, with its more or less *circular* ali- and orbito-sphenoids, and with the knowledge that a *gular plate* is found between the rami of its mandible.

We now return to our more typical Teleostean, *Micropterus salmoides*, and discuss other bones of its skull that I have as yet not touched upon in this memoir.

As in so many other bony fishes, we find in this Bass a series of irregularly-shaped bonelets, circumscribing the lower boundary of the orbit. These are the *suborbitals* (Fig. 27, *Sb. o.*). They are seven or eight in number, the hinder one resting on the postfrontal, while the large anterior one, which, in common with other osteologists, I have termed the *lacrymal*, overlaps, when in position, the maxillary and prefrontal (*La.*). On either side of the ethmoid, and what at first appears to be almost a continuation of this chain of bones, we observe another slender osseous element. This is the *nasal*. A mucus canal perforates its substance for its entire length (Fig. 27, *Na.*). In designating these bones as the nasals, I am aware it disagrees with what Sir Richard Owen has stated in his Anatomy of Vertebrates in the matter (Vol. I, pages 113 and 114), and must believe with Parker that "the proper nasal (*na.*) is a small ossification on each nasal roof, external to the supraethmoid in its middle region" (The Salmon, Morph. of the Skull, page 74). I must also believe, until some better observer corrects me, that the bone I have described as the ethmoid in *Megalops* and *Albula* is a single ossification in the adult, and the nasals of these forms I take to be missing in the specimens in hand. Resting on the forward end of the cranium in *Micropterus* we find a handsomely developed pair of *premaxillaries* (Fig. 27, *Pmx.*). Each bone has an ascending process in this region of its support, and when the two are properly articulated they form a graceful and nearly semicircular arch, the lower surface of which is thickly studded with very fine teeth. A rounded, lamelliform process is also developed on the upper side of the limb of each premaxillary, about one-third the distance above its pointed extremity (Plate VIII, Fig. 22).

The *maxillary* is a large bone, with expanded hinder extremity, on the upper border of which it supports an *admaxillary* (Figs. 27 and 22*a*). It is completely edentulous as in most other osseous fishes. Anteriorly it does not meet its fellow of the opposite side, but develops at this end, internally a circular and vertical disk, with a raised facet to articulate with the cranium. Another elliptical disk is found at this extremity, directed outwards. It is for the maxillary process of the palatine to play on. The form of the *palatine* in *Micropterus* is well shown in Fig. 22, *Pl.* This bone being firmly articulated with the palato-quadrate arch, and the maxillaries and premaxillaries being freely movable, the mechanism of these latter bones offers an interesting study. The manner in which they may move upon each other is easily seen in Fig. 22. This is still more engaging a subject in those fishes with protractile snouts, of which there are many genera.

In *Micropterus* the opercular group of bones is very well developed (Fig. 27, and Plate XIII, Fig. 32, *Op.*, *S. Op.*, *Pr. O.*, and *I. Op.*). The *operculum* is a beautiful scale-like plate of bone, the largest of the four. In outline it is an irregular quadrilateral, with a reinforced border on its anterior margin, which is so fashioned and strengthened at its upper

and anterior angle as to form a proper enlargement to support the articular facet for the hyomandibular. Viewed from without, its lower border overlaps for a couple of millimeters the *suboperculum*. This latter bone is shaped as shown in Figs. 27 and 32. Anteriorly it develops a pointed and upturned process, that lies between the lower angle of the operculum and the upper angle of the interoperculum.

The *interoperculum* has a quadrilateral outline, with the angles rounded off. Externally it is well overlapped by the preoperculum, and is attached to the mandible by ligament, while internally the epihyal and interhyal of the hyoid arch rest against it. In texture these three bones of the group are semitransparent and exquisitely marked with radiating and wavy concentric lines.

The *preoperculum* overlies all the other opercular bones, while it itself is overlaid by the hyomandibular above and the quadrate below. It is roughly crescentric in form, being carried to a gradually tapering point above, and strengthened throughout its entire length by a raised ridge of bone. On its inner aspect the lower limit of the hyomandibular, the interhyal, and the symplectic rest against it (Fig. 32).

It has been said that the opercular bones are but modified, or rather transformed, branchiostegal rays.

Situated beyond the opercula we discover another arcade of bones; this consists, from above downwards, of the *hyomandibular*, *symplectic*, and *quadrate*, the chain constituting the *suspensorium*. They connect, in *Micropterus* as in the osseous fishes generally, the cranium with the lower jaw (Figs. 27 and 32, *H. M.*, *Sym.* and *Qu.*). By the intervention of the *interhyal*, the hyomandibular has also suspended from its lower extremity the hyoid arch, and its upper and posterior angle, as we saw above, also articulates with the operculum. The hyomandibular is compressed from side to side, expanded above, to be gradually drawn down to a blunt point below, where it is united through a common cartilaginous bridge with the apices of the interhyal and symplectic. This latter element is wedged in between the quadrate and preoperculum, with the metapterygoid resting against its anterior border, it being merely a small bone that has been segmented off from the hyomandibular.

The *quadrate* is here, as is usually the case among fishes, a triangular bone of some size, articulating with the mandible at its lower angle (Fig. 27, *Qu.*). Against the upper half of its anterior border, by a very close suture, the ectopterygoid is placed, forming a part of the connection of the next arch beyond with the suspensorium. Upon the cranium the hyomandibular articulates with the postfrontal and squamosal in a long, narrow, longitudinal facet.

The arch next beyond the suspensorium is the *pterygo-palatine arch.* It is made up of the *metapterygoid*, the *ento-* and *ectoptergoid* and the *palatine.* This last element I have figured and sufficiently described above. In a great many fishes the palatine is movably connected at

the anterior extremity of the arch to which it belongs. The *metapterygoid* (Fig. 32, *M. Pt.*), a flattened and irregularly shaped bone is wedged in between the hyomandibular and quadrate, and firmly establishes the connection of the two arches at this extremity. It overlies also a thin scale-like process thrown out on the part of the *ectopterygoid*, just opposite the angle this bone makes above its articulation with the quadrate. The *ectopterygoid* is a bent and narrow strip of bone that directly connects the quadrate with the palatine. It forms the outer margin of the floor of the orbit, which is chiefly made up of the entopterygoid. Both the palatine and ectopterygoid support a dense area of very fine teeth upon their lower surfaces. The *entopterygoid* is a beautiful shell-like bone which is overlapped by the palatine anteriorly and the metapterygoid behind. It is bent upon itself at about its lower third towards the median plane, and thus forms the greater part of the floor of the orbit by its upper surface, and by its lower the roof of the mouth. The entopterygoid is quite transparent, and for some little distance from its outer margin marked by wavy and delicate concentric lines.

Although the bones just described are so intimately connected with the quadrate, I prefer to call this arch, as I have done above, the pterygo-palatine, considering the quadrate as the property of the suspensorium. It is often termed, however, the palato quadrate arch, and I took occasion to use this term in the first part of this paper.

Of the Hyoid and Branchial Arches of Micropterus.—Our large-mouthed black bass offers us very little that differs from the more typical Teleosteans in the skeletal parts of its respiratory apparatus. From the lower end of each hyomandibular there is, as we saw above, suspended a small rod of bone, the interhyal (the stylohyal of many authors). To these is articulated, on either side, a broad triangular piece, the *epihyal* (Fig. 32, *E. hy.*), which in its turn connects with the larger and longer piece, the *ceratohyal.* The connection between these two latter elements is very much strengthened by a longitudinal lashing of bony fibers on the inner aspects over the joint, the bones themselves being quite compressed and flattened plates of a form shown in the figure. The ceratohyals, the anterior pair, meet in front in a ligamentous symphysis, over which ride, side by side, two other separate elements, the *hypohyals* (*H. hy.*). These are broadly conical in form, with their apices drawn out into blunt processes, which are directed upwards and backwards. Resting upon the hypohyals above is an azygos bone about a centimeter long (in a bass that would weigh three pounds), which is the *glossohyal* (Fig. 27, *G. hy.*). It is a flattened bone, shaped somewhat like the vertical section of an hour-glass, it being the part of the skeleton which supports the soft parts of the tongue. This bone has also been called the *os linguale.* It may be absent in some of the true bony fishes.

In the specimen I have in my hand we see on the outer aspect of the epihyal, just above its lower and near its anterior border, two large and

curved branchiostegal rays, which in life are held in this position by ligament. The hinder and larger one is possessed of quite a blade-like extension, and the bone, like the rest of the series, is gently curved upwards. Two more branchiostegal rays are attached in a similar manner to the ceratohyal, the four bones being placed at about equal distances apart. The series of branchiostegal rays progressively increase in size from before backwards, the anterior ones being the most abruptly curved. The next two rays in order are attached to the lower margin of the ceratohyal, and I am under the impression that I have dissected specimens where a seventh ray has existed that was attached in order, beyond these, just within this border. As we know, the branchiostegal rays support a membrane of the same name, which forms sort of an auxiliary gill-flap.

Lying in the median plane, posterior to, but attached by ligament to the symphysis of the cerato-hyals, we find a plate of bone, that in the living fish separates the sternohyoid muscles. This bone is of a triangular outline, with its apex forward, a part of which bears a dilatation and *superior osseous loop* for a greater ligamentous attachment. Its lower margin is transversely expanded, and the plate is further strengthened by the development of an osseous rod that runs longitudinally through its center. This azygos plate is the *urohyal*, and is peculiar to fishes. In life it lies between the sternohyoid muscles, and is not always present where a glossohyal exists.

Aside from this *urohyal* and the branchiostegal rays, the bones we have been thus far examining constitute the *hyoid arch*, and this Bass presents it in what may be said a typical form for fishes, if anything can be adopted as a standard in form in a class where all the structures vary so in shape.

The relation of the various bones of the piscine skull and their functions, when we come to compare them with the homologous elements in the higher animals—man, for instance—has always presented to my mind one of the most interesting subjects in anatomy. Here in our specimen we have the hyoid arch, supporting, on either side, a series of branchiostegal rays. *These rays constitute the skeleton of an organ of defense to the respiratory apparatus.* It is believed by some that the opercular bones are modified branchiostegal rays, and these in their turn form the *lateral osseous wall of defense to the gill chamber, also the respiratory apparatus.* The *operculum articulates* with the hyomandibular of the suspensorium, which bone is said to be the representative of the *incus* of the human *ear*, while the lower bone, the *quadrate*, of the suspensorium, is a segmented portion of the *malleus*, another of the auditory ossicles in man. Now, in its turn the quadrate articulates with the *mandible* or lower jaw, a bone in one way subservient to the *digestive* apparatus.

Lying in the angle formed by the limbs of the hyoid, we find the branchial arches. The arrangement of these in *Micropterus* is so like it

is found in *Perca*, and the arches in this latter fish have become so well known both to layman and ichthyotomist, through the many reproductions made of Cuvier's old figure, that I have not thought it necessary to present a figure of this part of the skeleton to illustrate our subject. In the specimen of the bass in my hand, I find but *two* of the copulæ or basibranchials ossified. We remember that three of them ossify in the perch. Then follow on either side the five pair of segmented branchial arches common to the vast majority of the class; these bear the dentigerous patches on their upper surfaces—the gill-rakers being found farther back and on the outer pair only—while below they support the gills proper.

My collection contains specimens, however, where all three of the basibranchials are well ossified, and teeth appear on the upper surface of the rear one in two circular patches. The ultimate gill-raker is T-shaped, the horizontal bar being applied to the outer side of the arch.

The outer pair of branchial arches are each in two segments—a long, posterior, and inferiorly grooved pair, and an anterior or shorter pair that articulate with the middle of the indented sides of the mid-basibranchial. These latter are bent at a right angle, the long limb being continuous with the hinder segment; the short one, which is quite broad, is the part that meets the basibranchial. This description answers very well for the second branchial arch. The anterior segments of the third arch are much broader, and lie on either side of the ultimate basibranchial, while the fourth arch has no anterior segments; the posterior ones, or those that correspond to them in the other arches, touch each other in the median line.

The *infrapharyngeal bones* are broad, thickly studded with teeth on their superior surfaces, and drawn out into sharp extremities behind. Supported in the usual manner through the means of ligaments by the upturned portions of the arches, and lying beneath the cranium—the *suprapharyngeal* bones—are also thickly beset with teeth.

OF THE MANDIBLE OF MICROPTERUS.

We saw that the lower jaw of *Amia* ossified on either side from quite a number of centers; that it developed a large splenial and other separate elements. This is not the case, however, with the large-mouthed black bass. In this fish, as in many other Teleosteans, each ramus is composed in the adult of but three distinct pieces. These are the *dentary*, the *articular*, and the *angular* (Plate III, Fig. 15, *D. Art.* and *Ang.*). Owen tells us that "in both Sudis and Lepidosteus there is superadded a small bony piece, answering to the surangular of Reptiles." (Anat. Verts, vol. i, page 123.)

The *articular* of Micropterus (*Art.*) consists of a vertical and a horizontal portion, the latter being attached to its posterior half, and is extended backwards to bear the concave lunar facet to articulate with the quadrate. The articular surface of this facet, although on the hori-

zontal portion, of course, looks almost directly upwards. The upper aspect of this plate is marked by wavy lines, five or six in depth, that run round the bone parallel to its outer margin. Passing obliquely through the center of the bone is a mucus canal, the posterior opening of which is a circular foramen placed at the back of the articular process. The anterior opening is flattened and is opposite a similar canal that passes through the body of the dentary. The vertical portion of the articular is of a triangular form, and contains, in a canal in its substance, open on the inner aspect, running longitudinally at its base, the Mecklian cartilage (Fig. 15 *M.c.*). This cartilage passes into the dentary which ensheaths it nearly to the symphysis. The posterior border of the vertical plate of the articular is re-enforced by a thickened and raised rim, the laminated portion being beautifully marked by white lines running parallel to its superior margin. Radiating lines are also carried out to this border from the angle formed by its thickened posterior border and its line of union with the horizontal portion.

The inner posterior angle of the horizontal portion of the articular is completed by a separate piece of bone. This is the *angular*. It is triangular in form and unites with the articular in a roughened suture. This union is not so firm but that the piece comes away during ordinary maceration.

The two *dentary* pieces join each other anteriorly in the median plane in quite a firm symphysis. Thus formed, the entire bone constitutes the major part of the mandible, its superior border being thickly studded with rows of teeth. These rows become fewer in number, and the teeth progressively smaller as we proceed backwards, and they cease to appear within short distance of the posterior projections behind. Each dentary element, posteriorly in the vertical plane, is deeply notched by a triangular indentation (Fig. 15). At the anterior apex of this triangle enters the Mecklian cartilage. The limb below, of this fork, lies in the horizontal plane, constituting the hinder half of an elliptical plate of the dentary, similarly situated. It is through this part that the mucus canal is ensheathed, and into it on the inferior surface open three foramina placed a short distance apart. Other foramina pierce each dentary element on the outer aspect, half way between the symphysis and the apex of the postero-superior process. They are for the passage of vessels and nerves.

Huxley, in speaking of the mode of development that takes place in this region, tells us that "two ossifications commonly appear near the proximal end of Meckel's cartilage, and become bones movably articulated together. The proximal of these is the *quadrate* bone found in most vertebrates, the *malleus* of mammals; the distal is the *os articulare* of the lower jaw in most vertebrates, but does not seem to be represented in mammals. The remainder of Meckel's cartilage usually persists for a longer or shorter time, but does not ossify. It becomes surrounded by bone, arising from one or several centers, in the adjacent

membrane, and the *ramus of the mandible* thus formed articulates with the squamosal bone in mammals, but in other *vertebrata* is immovably united with the *os articulare*. Hence the complete ramus of the mandible articulates directly with the skull in mammals, but only indirectly, or through the intermediation of the quadrate, in other *Vertebrata*" (Anat. of vertebrated animals, p. 28, 29). Many of the Teleostei have various muco-dermal bones attached to, or connected with the skull, such as the chain of "supertemporals" that overarch the temporal fossa in some fishes. The most important of these in *Micropterus*, a pair on either side, I propose to call the *supralinear* ossicles (*sl*), as they overlie the anterior end of the lateral line. The largest and most external of these is shaped like a T, the ends of the horizontal portion resting on the squamosal on one hand, and the posttemporal on the other. The vertical limb is directed inwards and a little forwards, having attached to it by ligament the second piece, directed still a little more anteriorly. In the living bass these bones are easily detected, lying just beneath the skin in the lateral line as it arches over the temporal region.

OF THE SHOULDER GIRDLE OF AMIA CALVA.

My description of the girdle of *Amia* will be presented *pari passu* with that of *Micropterus salmoides*, the Teleost we have chosen for comparison in the skull as given above. The nomenclature of the various segments of this part of the skeleton is a matter of great importance, and without entering into any discussion upon this point, I propose here to adopt that of Professor Gill, as set forth in his Arrangement of the Families of Fishes, published by the Smithsonian Institution (November, 1872). Dr. Gill very tersely gives his reasons for departing from the older authors on this subject in the introduction of this valuable and classical paper. It is not necessary for me to repeat his remarks here, as they are now well known to ichthyotomists generally, having been in the hands of scientists for many years.

As the two tables Dr. Gill presents, however, are of great value, and will add so much to my remarks in the present connection, it gives me much pleasure to introduce these here. This eminent ichthyologist first treats of the girdle in Dipnoans, and says in review that "the homologies of the elements of the shoulder girdle of the Dipnoi appear then to be as follows":

Nomenclature adopted.	Owen.	Parker.	Günther.
HUMERUS.	Humerus.	Humerus.	Forearm.
CORACOID (or PARAGLENIAL).		Scapula.	Humeral cartilage.
SCAPULA.	Coracoid.	Supraclavicle.	Coracoid.
ECTOCORACOID (or CORACOID).		Clavicle.	
STERNUM.		Epicoracoid.	Median cartilage.
POSTTEMPORAL.	Scapula.	Posttemporal.	Suprascapula.

In this table I have omitted certain foot notes and quotations connected with it. As to "The Girdle in other Fishes" Dr. Gill remarks

that "the homologies of the elements of the girdle of Dipnoans with those of other fishes, and the added elements in the latter will be as follows":

	Cuvier.	Owen.	Gegenbaur.	Parker.
ACTINOSTS.	Os du carpe.	Carpal.	Basal stücke der Brustflosse.	Brachial.
CORACOID OF PARAGLENIAL.		Simple in Dipnoi and Ganoidei.		
HYPERCORACOID.	Radial.	Ulna.	Oberes Stück (Scapulare).	Scapula.
MESOCORACOID.	Troisième os de l'avant bras qui porte le nageoire pectorale.	Humerus	Spangenstück.	Precoracoid.
HYPOCORACOID.	Cubital.	Radius.	Vorderes Stück (Procoracoid.)	Coracoid.
PROSCAPULA.	Huméral.	Coracoid.	Clavicula.	Clavicle.
SCAPULA. ECTOCORACOID.	}	Differentiated only in Dipnoi.		
STERNUM.		Differentiated in Dipnoi.		
POSTTEMPORAL ELEMENTS.				
POSTTEMPORAL.	Suprascapulaire.	Suprascapula	Sapraclaviculare (*a*).	Posttemporal.
POSTTEROTEMPORAL.	Scapulaire.	Scapula.	Supraclaviculare (*b*).	Supraclavicle.
TELEOTEMPORALS.	Os coracoidien.	Clavicle.	Accessorisches Stück.	Postclavicles.

Among Teleosteans, as a rule, the *posttemporal*, a forked bone (Plate VIII, Figs. 23, 24 *Pst. T.*), has its inner limb resting on the epiotic, and its outer one resting against or articulating with the pterotic. In some fishes, as the Cats, this limb comes lower down on the side of the cranium.

The *posttemporal* of *Amia*, although it has on side view (Fig. 24) very much the appearance of this bone in *Micropterus*, this is by no means the case on superior view. In the Ganoid the bone is much spread out horizontally and sculptured for a narrow strip just within its external border, like the "cover-bones" of the skull. Moreover, its inner limb, in *Amia*, articulates with the epiotic, while its outer and lower one, a rounded prong, meets the opisthotic.

The *posttemporal* in *Micropterus* is placed much more in the vertical plane; the anterior extremity of its somewhat compressed and longer upper limb rests on the epiotic, while its lower and shorter limb abuts against the pterotic. A process in both these fishes projects backwards from this fork of the posttemporal, against the inner aspect of which the *posterotemporal* articulates. This latter is a scale-like element, with rather a rounded superior head. Its posterior border is deeply notched in *Amia*, and in both cases its flat surface is nearly parallel with the median plane (Figs. 23 and 24, *Psto. T*). Resting on the inner surface of the lower fifth of the *posterotemporal* in *Amia*, we see the upper *teleotemporal* and the superior part of the vertical portion of the *proscapula*. This arrangement is far different in *Micropterus*, where the *teleotemporals* do not come in contact with the *posterotemporals* at all. The *teleotemporal* of the Mudfish is of a quadrilateral outline, and this Ganoid is without any lower *teleotemporal* (Fig. 23 *T.*).

In *Micropterus* there are two of these bones, an upper and a lower one, attached to the other elements of the girdle by ligaments. The upper piece is a scale-like bone parallel to the median plane, while the lower segment is a straight spine resting upon the inner aspect of the entire length of its anterior border (Fig. 23 *T.*). This lower *teleotemporal* was regarded by Carus as a displaced iliac bone. These *teleotemporals* of the bass rest against the coracoids, and above the *proscapula* (Fig. 23). This latter element in *Amia* presents for examination a vertical portion, which has a strong process developed, directed upwards, at its antero-superior angle, a feature it holds in common with *Micropterus.* Now, the outer aspect of this vertical portion is sculptured in *Amia* like the opercular bones, while in the bass it is marked like its own opercular bones, with white, wavy lines and radiations.

The proscapula of *Amia* next sends off anteriorly from its vertical plate, nearly at right angles, a longer and broader portion. This part is pointed at its further end where it articulates with the fellow of the opposite side by ligament. Its upper surface is gently convex, and its inner margin is fortified by a raised rim, directed downwards. This rim, similarly situated, becomes a prominent feature in *Micropterus* (Fig. 23), and the coracoids articulate at its lower edge. They occupy nearly the same position in *Amia*, but here they have become completely amalgamated and are represented only in cartilage (*Yn.*). *Micropterus* lacks a mesocoracoid, but both the *hyper-* and *hypocoracoid* are thoroughly developed. The hypercoracoid is perforated about its middle by an elliptical foramen (Fig. 23, *Hyp. c.*), which is met in many other Teleosteans. Above, this bone articulates with the proscapula, as described above; anteriorly it articulates with the hypocoracoid (*Hyo. c.*), lying in the same plane, while below it articulates with three of the actinosts; the fourth and largest of these bones articulating with the hypocoracoid. This latter bone throws forwards a long, lamelliform spur that reaches far forwards on the under side of the proscapula. It shows a rounded notch behind, just anterior of the facet for the lower actinost. There are *four actinosts* in *Micropterus*, shaped like little dice-boxes, and forming a graded series as regards their size. From their hinder ends spring the sixteen rays that go to form the *pectoral fin* (Plate XIV, Fig. 35, *Ast. Pf.*). I find nine actinosts in the carpus of *Amia*, composed of very elementary bone, with dilated posterior ends, to which are attached the twenty-two rays of the pectoral fin. We cannot see all of these in Fig. 24, because the view does not admit of it, but they are correct in Fig. 35. Delicate markings encircle these rays for their entire length, commencing a short distance beyond their anterior ends.

These members, after passing backwards for about half their distance, divide in two, the forks keeping close side by side and one above the other. This phenomenon is repeated once more before arriving at the posterior margin of the fin. A similar splitting of the fin rays

obtains also in the Mudfish. Here, too, the rays, if maceration is carried to excess, cleave in twain longitudinally, but as this can be studied to better advantage in the caudal rays of this Ganoid, I defer saying anything more about it until that part comes to be described.

In *Micropterus* the apex of the united pelvic bones are inserted posteriorly into the angle formed by the articulation of the proscapulæ. The pelvic bones are situated, as we shall see further on, far back in *Amia*, and differ very much in their general character.

Upon the outer side of each proscapula in *Amia* are found a pair of very curious-appearing scales, composed apparently of a toughened membrane, marked in an irregular manner by lines of semi-osseous material, that require the aid of a lens to properly study. These peculiar affairs are attached loosely to the sides of the proscapulæ, but up to the present writing I am not aware that any physiologist has advanced a theory as to the original function of these appendages. They have no evident use now. In referring to these interesting structures, Dr. Wilder says that[64] "upon each side of the *copula*, or isthmus, which connects the shoulder-girdle of *Amia*[65] with the hyoid arch, there are two appendages which are rarely mentioned by authors, and whose nature appears to be undetermined."[66]

"*Historical sketch.*—According to Duméril,[67] these appendages are what Linnæus referred to in the following phrase, to which zoologists who have spoken of *Amia* do not appear to have attached a definite significance: *Gula ossiculis, scutiformibus, e centro striatus.* Valenciennes supposed that he was impressed by the appearance of the branchiostegal rays, which form on each side a sort of striated plate; but in the phrase cited reference is evidently made to the two small dentated pieces of which I am speaking, and which is easy to see. I have also found them mentioned by Stannius." With further quotation from Duméril, the doctor says, "The appendages are not mentioned in Franque's description of *Amia*, nor in the monographs or systematic

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[64] Wilder, Burt G., on the Serrated Appendages of the Throat of Amia, Proc. Amer. Assn. of Science, 1876, page 259.

[65] *Amia* is a fish found living in the Mississippi River and its tributaries, and in the great lakes. It attains a length of two feet, and is called by fishermen "mudfish," "dogfish," and "lake-lawyer." Under the tip of the lower jaw is a movable plate, which does not exist in any other fresh-water fish of America. The adult male has a circular dark spot at the base of the tail (Jordan, 23, 306). *Amia* is now usually regarded as a ganoid, and its brain closely resembles that of Lepidosteus (the gar-pike); but it seems to be, as remarked by Gill (10), the "most teleosteoid" of that group. [This foot-note is from Dr. Wilder's article.]

[66] I regret to say that it proved to be impracticable to reproduce Dr. Wilder's figures in his very instructive plate.

[67] I have omitted, in this long but important quotation from Wilder's paper, the figures which this author gives that refer to the bibliographical table at the end of his article. Those who wish to refer to the authorities quoted will have to turn to the Proceedings containing this list. So short is Dr. Wilder's paper, and yet his observations are so valuable in the present connection, that I have incorporated them quite extensively, a fact that the reader no doubt will appreciate.

works of Agassiz, Cuvier, Cope, DeKay, Gill, Günther, Huxley, Jordan, Müller, Owen, Rolleston, or Vogt."

With regard to their location and general appearance, this author states that "in the adult *Amia* there are two appendages on each side. They are usually concealed from view by the operculum; but the tip of the hinder one sometimes projects beyond the operculum at a point a little above the base of the pectoral fin. The anterior appendage is about 2 centimeters long, and its anterior extremity is a little more than half its length from the union of the isthmus with the hyoid arch. Its hinder end is nearly opposite the medium tip of the shoulder-girdle. It is wholly superficial, and its hinder border projects but slightly beyond its attachment. The posterior appendage is about twice the length of the anterior, and consists of three portions: a short triangular *root* just beneath the skin; a short but broad *base*, the deep surface of which is continuous with the skin; a long *free* portion, which gradually tapers backward to the tip, which is less than 1^{mm} wide. The root lies to the mesial side of the posterior extremity of the anterior appendage, but there is a distance of nearly 2^{mm} between them. The posterior appendage inclines dorsad, and rests quite closely against the adjacent surface of the shoulder-girdle.

"Neither has any direct connection with bone. The attached surfaces rest upon the muscles which constitute the isthmus, but do not appear to be attached to them. While observing living *Amias* with reference to their respiratory function I never saw any movement of these appendages. The thickness of the posterior one is about $\frac{1}{2}^{mm}$. It is quite flexible during life and while moist, but becomes more rigid when dried.

"The free surfaces of both appendages are corrugated in the adult. The general direction of the ridges and furrows is across the length of the surfaces obliquely forward from the dorsal toward the ventral border. The ridges are more or less wavy in outline, and present irregularities of direction and arrangement, especially toward the tip and ventral border of the posterior appendage. But the distance between any two ridges is quite uniform; the number of ridges being about 18 to the centimeter upon the anterior appendage, and about 12 upon the posterior. The transverse ridges do not always reach the ventral border upon the anterior two-thirds of the posterior appendage; the ventral third of the surfaces is in some cases nearly free, but may present one or more ridges running nearly parallel with the border, or more often, especially on the inner surface, there may be a series of short ridges trending dorsad and *forward* from the lower border to meet the dorsal series at open angles.

"The anterior slopes of the ridges form an angle of about 45° with the surface; but the posterior slopes are nearly perpendicular. The crests are projected backward as numerous fine teeth which are barely visible to the naked eye."

This author then proceeds to give an interesting account of the development of these appendages, and in the matter of structure says they "consist mainly of fibers running longitudinally. I have not yet examined them under the microscope." The doctor is under the impression he has detected homologous structures in *Lepidosteus*, but as to their function he remarks that "I am not aware that any use has been assigned to these appendages, and I have no suggestion to offer. The anterior is evidently passive. The posterior, even if voluntarily movable by the fish, is too flexible for offense, and is, moreover, covered by the operculum," and with regard to morphological significance "unless some function can be assigned to these appendages the conclusion that must naturally suggests itself is that they are remnants of organs which had greater size and performed some function in more or less remote ancestors of *Amia*. The position and general appearance of the posterior pair are not wholly contradictory of the idea that they may have been accessory branchiæ; but this could hardly be surmised respecting the anterior pair, or the supposed homologous parts of *Lepidosteus*. The appendages should be examined in fossil *Amia* and *Lepidosteus*, and in other extinct Ganoids; likewise should careful search for them be made in all living Ganoids, and in the Teleostean genera *Elops* and *Megalops*, which possess some points of resemblance to *Amia*."

The opportunity has never been offered me to examine either of these latter forms with the view of searching for these structures, and at the present writing I am aware of no one who has thrown any further light upon this subject since Dr. Wilder made the above observations.

OF THE PELVIC BONES AND VENTRAL FINS OF AMIA.

In speaking in a general way of these structures, Professor Huxley remarks, that "In all Elasmobranchs and Ganoids, and in a large proportion of the Teleosteans, the pelvic fins are situated far back on the under side of the body, and are said to be "ventral" in position; but, in other Teleosteans, the ventral fins may work forward, so as to be placed immediately behind, or even in front of the pectoral fins. In the former case they are said to be "thoracic," in the latter "jugular." (Anat. Vert. Animals, p. 39.) These pelvic bones in our subject are quite well ossified, and hold a typical "ventral" position. (Plate X., Fig. 26.) They are in two distinct pieces, each piece being shaped like a paddle, with the blade directed forwards. In life they lie side by side just beneath the skin, with the expanded blades in the horizontal plane. Their anterior extremities are cut square across, while posteriorly they are enlarged so these aspects present an elliptical face in each case. In a specimen of *Amia* with a vertebral column 30 centimeters long, I find the pelvic bones each to measure 2½ centimeters in length. So far as this description goes it agrees very well with these parts, as they are figured and described by Franque, but I find other structures here that apparently are not referred to, in either way, by this anatomist. Now, we discover behind each pelvic bone in *Amia* and articulating with the

posterior elliptical facet described above, another bone of a conical form, and about one-half a centimeter long. This element seems to take the place of the combined actinosts of the pectoral limb. Again, the rays of the ventral fins are arranged in a peculiar manner; these, which seem to number from seven to eight in an adult specimen, are split as they are in the pectoral rays. The ends thus divided are held well apart in order to allow the separate conical piece of bone to be inserted between them. As in the pectorals, too, these ventral fins are "branched" as they approach their posterior terminations. In form each fin is quite acute and the outer ray is the longest.

Among the Teleosts the pelvic bones not only vary in position, but, as we might readily imagine, vary almost infinitely in regard to their relative size and shape. Indeed, it would be a difficult thing to convey any adequate conception in such an essay as this, of these various forms. They are as numerous, nearly, as the species themselves. These bones are never attached to the vertebral column as we find them in vertebrates above fishes. (Owen.)

In *Micropterus salmoides* they are represented by two separate and symmetrical bones, that articulate with each other mesially, by their inner edges. When thus united they form an elongated isosceles triangle, with its apex held by ligament in the entering angle behind the proscapulæ. The outer borders develop a raised rim, and the planes of the surfaces contributed by the two bones superiorly, on either side, look upwards and outwards, the reverse being the case, of course, beneath. The postero-external angles, as well as the hinder border, is thickened and undulating for the articulations of the heads of the ventral fin rays. There is, also, a characteristic process developed mesially on this border, into which each pelvic bone takes an equal share. Above, it is bifid, being directed upwards and backwards, and compressed anteroposteriorly; below, it is peg-shaped and directed in the same degree forwards and downwards.

I fail to find any bony nodules, representing the actinosts, between the ventral fin rays and the pelvic bones in this fish; and the rays themselves seem to be constructed upon the same plan as the pectoral ones, being retained in their positions by firm ligaments and the skin. The outer one, however, on either side, differs materially in form, being spoon-shaped, with the concavity against the next ray on its inner side. It also develops an inturned process, which curves over the next two or three rays. This double arrangement seems designed to strengthen the inner rays, and assist to keep them in their position.

OF THE VERTEBRAL COLUMN, AND SKELETON OF THE REMAINING PARTS.

FIGS. 14, 25, and 26.

Among the general characters of this part of the skeleton we know that "the vertebral column of fishes can only be divided into two re-

gions, the body and the tail. They are distinguished from each other by the characters of the inferior processes of the vertebræ, while the upper arches are connected with the vertebræ in the same manner throughout; and are generally distinguished by the possession of median (spinous) processes. In the region of the trunk, the lower arches are divided into ribs, and supporting transverse processes (parapophyses). In the tail of the Selachii and Ganoïdei they are continuously connected with the centrum, and run out into spinous processes, just like the upper arches." (GEGENBAUR, Elem. Comp. Anat., p 430.) Again, among fishes, generally the vertebræ of the tail develop inferior arches through which the caudal vessels pass. The segments of the column beyond these support ribs which arch over the viscera, but never meet with any sternum mesially, on the ventral parietes. The fins have a skeleton of osseous rays which are supported upon the interhæmal spines.

So well known are they that it is not my intention in the present connection to enter upon the study of the scales of *Amia*. It is sufficient to say that they are of the cycloid type of structure and constitute the exoskeleton of this fish, being arranged much as we find them in the typical Teleosteans.

Anatomists have long understood the morphology of the skeletal parts of the tails of fishes. Professor Huxley tersely presents the conditions for us in these words, when he says that "In all Teleostean fishes the extremity of the spinal column bends up, and a far greater number of the caudal fin-rays lie below than above it. These fishes are, therefore, strictly speaking, heterocercal. Nevertheless, in the great majority of them (as has been already mentioned, page 19), the tail seems, upon a superficial view, to be symmetrical, the spinal column appearing to terminate in the center of a wedge-shaped hypural bone, to the free edges of which the caudal fin-rays are attached, so as to form an upper and a lower lobe, which are equal, or subequal. This characteristically Teleostean structure of the tail-fin has been termed homocercal—a name which may be retained, though it originated in a misconception of the relation of this structure to the heterocercal condition."

"In no Teleostean fish is the bent-up termination of the notochord replaced by vertebræ. Sometimes, as in the salmon, it becomes ensheathed in cartilage, and persists throughout life. But, more usually, its sheath becomes calcified, and the urostyle thus formed coalesces with the dorsal edge of the upper part of the wedge-shaped hypural bone, formed by the anchylosis of a series of ossicles, which are developed in connection with the ventral face of the sheath of the notochord." (Anat. of Vert. Animals, page 131.)

There are ninety vertebræ in the spinal column of *Amia calva;* they are of the amphicœlous type, and devoid of zygapophysial processes (Fig. 14). The centra of these vertebræ are thoroughly ossified, but their

neural and hæmal arches remain free throughout life, articulating with them upon certain facets that are overlaid by their cartilage.

I fail to find a pair of ribs attached to the first free vertebra or what now corresponds to the "atlas." Its neural arch has an independent spine, articulating with it, and directed backwards. A similar spine, only longer, is found in a like position on the neural arch of the second and third vertebræ. Three or four others follow in sequence behind these, but they have no apparent connection with the neural arch of the vertebræ. The second vertebra supports a delicate pair of ribs, which articulate *directly* with the sides of its centrum. In the third segment a small pair of parapophyses have made their appearance, and the ribs of this vertebra articulate with their outer extremities. These parapophyses are characteristic of the vertebræ to the thirty-seventh inclusive. They are always directed downwards and outwards; are longest in mid series, but as they proceed backwards are situated lower down on the centrum of the vertebra. The ribs are long and slender and become more so as we proceed towards the tail; in every case they articulate with the extremity of the parapophyses.

The extremity of the neural spine of the sixth vertebra in *Amia* is bifurcated, and this feature is present for about two-thirds the way down the column; these spines being directed upward and backward, with the ones over the middle of the abdominal cavity more decidedly backwards, though the rear spines are the most deeply bifurcated. Twenty of the ultimate ones are simple in their structure. Not very well marked parapophyses are found upon the thirty-eighth vertebra, and this segment is without a pair of ribs. The neural arches inclose quite a capacious neural canal, and their bases articulate between each consecutive pair of vertebræ, these latter having a form to accommodate themselves to this unique condition (Fig. 26). No neural arch is found upon the forty-fifth vertebra, and from that onwards they only occur upon the alternate segments. In the thirty-ninth vertebra, what would at first appear to be the parapophyses in the anterior part of the column, are here much larger, freely articulated, and inclose a canal by the union of their extremities beneath, in the medium plane. These also skip *the same* vertebra as the neural arches do above them on the column; fourteen of them also support a free spine from their mid points below. After this they are united and pass round the bent-up vertebral column, becoming broader and gradually shorter, where they support the caudal fin rays (Fig. 25). The last six or seven of these *hæmal spines* appear to be anchylosed with the vertebræ.

I count in my specimen before me, fifty-three bony rays in the long dorsal fin; these branch above, and the ultimate ones branch a second time. These rays are supported by an equal number of *interspinous bones*, through the intervention of little ossicles that pass obliquely from one to the other (Fig. 25). All this part has been quite correctly figured by Franque, but this author overlooked a series of delicate little

bones that continue the interspinous bones of the dorsal fin as far as the caudal fin. These are five in number and are seen at *jf* in Fig. 25. The rays of the dorsal and anal fin split longitudinally, as I described them for the pectoral and ventral fins. The anal fin possesses twelve rays in its membrane, and likewise twelve interspinous bones support it, of which the majority in the mid-series have intermediate ossicles as in the dorsal fin. These little bones are each shaped like a dice-box, and not as Franque has represented them in his drawing.

My representation of the skeleton of the tail of *Amia* I have taken so much pains with to secure its accuracy that I believe any verbal description of the parts hardly necessary. (Fig. 25.) More time than usual was devoted to this figure, because the illustrations of this part of *Amia's* anatomy that it has been my pleasure to examine are far from being correct; they are carelessly drawn or simply diagrammatic in character (Kolliker's).

There are twenty-five rays in the caudal fin of this Ganoid. Of these, the two superior ones are very delicately fashioned, the next two are long and slender, while the stoutest ones are found in the middle, from which series they gradually become smaller again as we proceed downwards. In the prepared specimen all of these rays are found to be split longitudinally in the vertical plane, and those chosen from near the middle of the member are found to be branched to the third or fourth division. They are also marked at irregular intervals by raised and transverse divisions. The splitting spoken of allows these rays to seize by their anterior ends the hypural bones coming from the vertebral column, which they do in the manner shown in the figure. In this, the best living example of a masked heterocercal tail, the notochord, being insheathed only in cartilage, has, of course, disappeared in the figure. It is in *Polypterus* that we find nearly the type of what has been termed the "diphycercal" tail, in which the notochord is scarcely bent up at all. Our example of *Micropterus* shows in a marked degree the remaining style of the skeletal parts of the tail in osseous fishes. This is well known to us under the term of the *homocercal* type, and in this fish shows a very completely ossified urostyle, directed upwards and backwards at an angle of about 45°, with a markedly straight vertebral column. The hypural plates are also very broad and perfect in this bass, and the fin rays, very similar in construction with those described for *Amia*, are attached to them in the same manner. As in so many osseous fishes, *Micropterus* has on either side, close to and between the column on the third hypural plate, a sharp, upturned process. This I believe is intended to afford additional surface and leverage for the origin of the muscle that controls the movements of the tail.

In speaking of this part of *Amia's* anatomy Wilder says [68] that "the

[68] Wilder, Burt G., On the tail of *Amia*. Proc. Amer. Association for the Adv. of Science, 1876, pages 264–266.

tail of *Amia* has been figured and described by Franque, Kölliker, and Huxley." [69]

Kölliker's paper is known to me only through the quotations by Duméril. Franque represents only the osseous portions of the skeleton. Huxley gives both form and structure, but not, as it seems to me, quite accurately. Neither of these authors mentions the young *Amia*, or intimates that the form or structure of the tail may vary with age. In discussing the external form this author further remarks that "Dumeril says that the tail of *Amia*, as to its external appearance, differs in no way from that of the ordinary osseous fishes. Its heterocercy, however decided, is well manifested only by the skeleton." Huxley does not allude to the form, but his figure does not very distinctly indicate any difference between the tail of *Amia* and that, for instance, of some Siluroids, where the whole is rounded, and the greatest length is midway between the dorsal and ventral borders."

And, continuing, in the same article he sums up the results of his valuable observations, and says: "I have examined many examples of *Amia*, young and adult, and all manifested the following features:

"1. The greatest length of the tail is considerably above the middle of its height.

"2. The change from the nearly horizontal dorsal and ventral borders to the curved posterior border occurs farther forward upon the ventral side. These features render the ventral slope both longer and more gradual than the dorsal.

"3. When the tail is fully expanded, as while the fish is swimming, the dorsal and ventral slopes meet, so as to form a gentle curve, and not an obtuse point, as in Huxley's figure. This is well shown in (Fig. 3 representing) the tail of a young example in the condition assumed at death.

"The tail of *Lepidosteus* presents the same general features, with some specific variation. Hence, with both these ganoid genera the external form of the tail is decidedly, though not very obviously, unequal."

My interest was first awakened in the structure of *Amia* more than ten years ago, at which time I was permitted to attend Dr. Wilder's lectures at Cornell University, where dissections upon *Amia calva* always held a prominent place. In those days, however, if I remember correctly, Dr. Wilder had made but few, if any, dissections of the young of *Amia*, so it affords me additional pleasure and a peculiar satisfaction to further quote from his paper in the Proceedings his remarks upon the structure of this part of the mudfish's anatomy, supplemented, as it now has been, by studies in that direction. Of it he says that "the terminal caudal vertebræ form an upward curve,

[69] I have, for obvious reasons, referred to elsewhere in this article, omitted Dr. Wilder's number references to his bibliographical table at the end of the above paper in the Proceedings; as well as the references in his text to the figures of his instructive plate.

as shown by Franque. Huxley's figure and description show that the notochord, enveloped by cartilage, extends upward toward the dorsal border of the tail. In all the adults examined by me the termination of this compound rod is considerably nearer the dorsal border than is indicated by Huxley's figure, and presents a rather broad and but slightly rounded tip, with a central depression corresponding to the neural or spinal canal. Here ends the distinct cartilage. Posterior to it, and between the two laminæ of the twenty-first or twenty-second fin-ray (counting from below), is a tract of gelatinous matter, which Kölliker, as quoted by Duméril, seems to have regarded as the prolongation of the notochord. I have been unable to detect any difference between this and the tracts of gelatinous matter between the laminæ of the other caudal fin-rays.

"But that it may fairly be regarded as the prolongation of the notochord, degenerated, and not enveloped by a cartilaginous sheath, is rendered at least probable by the following considerations:

"1. The condition of things in the adult *Lepidosteus*, as described and figured by Kölliker and myself; the notochord with its cartilaginous sheath forming a slender tapering rod, extending between the halves of fin-rays to the junction of the middle and hinder thirds of the tail.

"2. The existence of an undulation of the dorsal border of the tail of *Amia* corresponding with the termination of the supposed notochord.

"3. The greater distinctness of this undulation in young individuals."

This interesting paper concludes with remarks upon "transformation" and "variations in the shape of the tail."

Counting the one from which the urostyle springs, *Micropterus* reckons thirty-two vertebræ in its spinal column, fifteen of which are abdominal. These latter all support each a pair of ribs, which in their turn, all save the last four pair, have epipleural appendages. The atlantal pair articulate with the vertebra at the very base of the neural arch, but as we proceed backwards they gradually recede from this position so as to finally spring from *beneath* the transverse processes on the under side of the vertebra. This condition is characteristic of a great many of the osseous fishes. The neural and hemal arches of this form are completely anchylosed with the vertebral elements, and in the best developed segments, both superior and inferior, post- and prezygapophyses are present.

The arrangement of the osseous fin-rays and interspinous bones in *Micropterus* differs somewhat, to be sure, from the arrangement of these parts in *Amia*, but not at all from what we have known to exist so long in Teleostean fishes, as in *Perca* for example.

Thus we see it is, that although the Ganoid *Amia calva* has in its skeleton many of the characters in common with the highly specialized forms as the Teleosteans, it is, on the other hand, still stamped with characters, more particularly in its vertebral column, of a veritable paleoichthyic type.

LIST OF THE PRINCIPAL WORKS, COMPRISING OTHERS THAN THOSE CITED IN THE FOOT-NOTES, THAT HAVE BEEN EITHER REFERRED TO OR EXAMINED DURING THE PREPARATION OF THIS MEMOIR.

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EXPLANATION OF THE REFERENCE LETTERS USED IN THE PLATES.

[NOTE.—In many instances in Dr. Sagemehl's article the letters in his text do not agree with the reference letters of the figures in his plate; then, again, Franque used a different system of letters, as did the writer. This gave much trouble; but it is hoped that in the explanation of these letters, here given, the references will all be made clear, both for the text and the figures.—R. W. S.]

a. Admaxillary; frontal (Fig. 7, Plate II); also one of the ossifications of Meckel's cartilage (see Plate V, Figs. 17 and 18), and α a ligament between nasal and frontal. [Franque.]

αg. Angular. [Bridge.] (See Plate V, Figs. 17 and 18.) Also *Ang*. (Plate III and others.)

An. Preorbital (Plate IV, Fig. 16); antorbital.

an. Angular (Plate VII).

Art. Articular (P^5, os condyloideum of Franque, Plate X).

As. Alisphenoid.

Ast. Actinosts.

β. *Ossa in cutem immissa* (Franque), supratemporal of the author

b. Parietal of Franque (Fig. 7).

b. One of the ossifications of Meckel's cartilage (Plate V, Fig. 17).

b. a. Branchial arches.

B. O. Basioccipital.

Brs. R. Branchiostegal rays.

B. S. Basisphenoid.

Bs. b. Basibranchials.

c. One of the ossifications of Meckel's cartilage in Plate V.

c. Os mastoideum (Franque), the squamosal of the other figures; *Sq*.

ca. Carotid foramen.

cb. Vascular canal of the occiput (in basioccipital).

ce. External semicircular canal.

C. hy. Cerato-hyal.

cp. Posterior semicircular canal.

cr. Coronary cartilage (Bridge), Plate V, Fig. 17.

Cs. Anterior semicircular canal.

c. v. Neural arch of first vertebra in *Albula* and the co-ossified first vertebra in *Megalops*.

D. Dentary.

d. One of the ossifications in Meckel's cartilage. (Bridge.) Plate V.

d. Nasal. (Franque.) Pl. II, Fig. 7.

d'. Os alare (Franque); the author's antiorbital, while Franque's antorbital *h* I have the lacrymal.

δ'. Posterior nasal aperture. (Franque.)

e. Ethmoid of Franque. (Pl. II, Fig. 7.)

Ecpt. Ectopterygoid.

E. hy. Epihyal.

Enpt. Entopterygoid.
E. O. Exoccipital. (See also *Ex.*, Fig. 1.)
ep. Epiphysial crest.
Ep. O. Epiotic.
Esc. Extrascapula. (Sagemehl.) Fig. 1.
Eth. Ethmoid.
Ex. Exoccipital. (Sagemehl.)
F. Frontal.
f. Superior maxilla. (Franque.) Pl. X, Fig. 26.
fa. Foramen for exit of facial nerve.
fh. Hypophysial foramen.
g. Intermaxillary. (Franque.)
G. hy. Glossohyal.
gph. Foramen for glossopharyngeal nerve.
G. pl. Gular plate.
h. Antorbital. (Franque.) Pl. II, Fig. 7.
H. hy. Hypohyal.
H. M. Hyomandibular.
hm. Articular facet for hyomandibular.
Hyo. c. Hypocoracoid.
Hyp. c. Hypercoracoid.
i. Infraorbital bones. (Franque.) (Pl. X, Fig. 26.)
ih. Interhyal.
I. Op. Interoperculum.
Jc. Intercalare (opisthotic). Dr. Sagemehl evidently meant *Ic.* to appear on his figures, and this must be a mistake of his engraver.
jf. Continuation of interspinal bones. (Not previously described.)
jn. Membranous tract extending between frontals and nasals.
k. Postorbital. (Franque.) Pl. II, Fig. 7.
k, k′, k″. Designate, with a small unnumbered piece above them, a disconnected chain of bones, that are sometimes found in *Amia*, between the postorbitals and preoperculum. (Plate IV, Fig. 16.)
La. Lacrymal.
m. c. Meckel's cartilage in Plate III, Fig. 15.
mk. Meckel's cartilage. (Bridge.) Plate V, Fig. 17.
M. Pt. Metapterygoid.
mt. mk. Mento-Meckelian bone.
Mx. Maxillary.
n. Suprascapula. (Franque.) Plate II, Fig. 7.
Na. Nasal.
*Na*². A semicartilaginous piece of bone found in *Albula vulpes*. Figs. 29, 30.
Ob. Basioccipital. (Sagemehl.)
Oc. I, Oc. II. First and second occipital arches of *Amia*. (Sagemehl.)
oc. I, oc. II, and *oc. III.* Foramina of exit of the first to the third occipital nerves in *Amia*. (Sagemehl.)
oc. r. Occipital ribs in *Micropterus*. (Shufeldt.)
Ol. Occipitale laterale. (Sagemehl.)
ol. Opening for nasal nerves.
Op. Operculum.
op. Optic foramen.
Os. Orbitosphenoid.
P. Inframaxilla. (Franque.)
P1. Dentary.
P3. Coronoid.
P5. Os condyloideum.

Pa. Parietal.
Pe. Petrosal. (Sagemehl.)
Pf. Pectoral fin.
pl. Dr. Sagemehl gives this in his figures, but not in his list.
Pmx. Premaxillary.
P. Op. Preoperculum.
P. or. } Postorbitals.
P. or[1]. }
Prf. Prefrontal.
Pr. O. Proötic.
Pr. S. Parasphenoid.
P. Sc. or *Ps.* Proscapula (Plate XIV, Fig. 35). *Ps.* Parasphenoid of Sagemehl.
Psf. Postfrontal.
Psto. T. Posterotemporal.
Pst. T. Posttemporal.
Pt. O. Pterotic.
Pv. Pelvis.
q. Operculum. (Franque.)
q^1. Interoperculum. (Franque.)
q^2. Suboperculum. (Franque.)
q^3. Preoperculum. (Franque.)
Qu. Quadrate.
ro. Facet for articulation with operculum.
s. Os pterygoideum externum seu transversum. (Franque.)
Sag. or *S. Ang.* Surangular.
Sb. o. and *Sb. o*[1]. Suborbitals.
Sc. Suprascapula.
S. eth. Supraethmoid.
sl. Supralinear.
Smx or *Sm.* Intermaxilla, septomaxillary.
S. O. Supraoccipital.
S. Op. Suboperculum.
Sq. Squamosal.
S. tp. Supratemporal of Bridge and the author; extrascapula of Sagemehl.
Sym. Symplectic.
T. Teleotemporal.
T^1. Lower teleotemporal.
T^{11}. Teeth.
tg. Temporal fossa.
tr. Foramen for the first branch of trigeminal nerve. *Tr.* For the second and third branches of the same.
v. Foramen for exit of vagus.
V. f. Ventral fin.
vg. Vagus foramen.
Vo. Vomer.
x. Two small pieces of cartilage posterior part of cranium of Amia. (Sagemehl.)
Yn. Coracoid of *Amia* (in cartilage).
z. One of the ossifications of Meckel's cartilage; the one marked *a* in Plate V, Figs. 17 and 18.

PLATE I.

FIG. 1. Cranium of *Amia calva* from above; life size. The dark piece projecting at the lower right-hand angle is the continuation of *Sc.* The little piece at the anterior end of the frontal suture is in cartilage, as is *ol*, and the triangular wedge at the inner end of *Esc.* Sagemehl's original plates have all the cartilage tracts in color, a pale blue. This could not be carried out in the present connection. The lightly stippled and unlettered parts, generally, are in these figures, however, the cartilaginous tracts.

FIG. 2. The same specimen, cranium seen from below.

FIG. 3. The same specimen, the parasphenoid (*Ps.*) and the vomers (*Vo*) having been removed. (These three figures copied from Sagemehl's plates by Mr. H. L. Todd.)

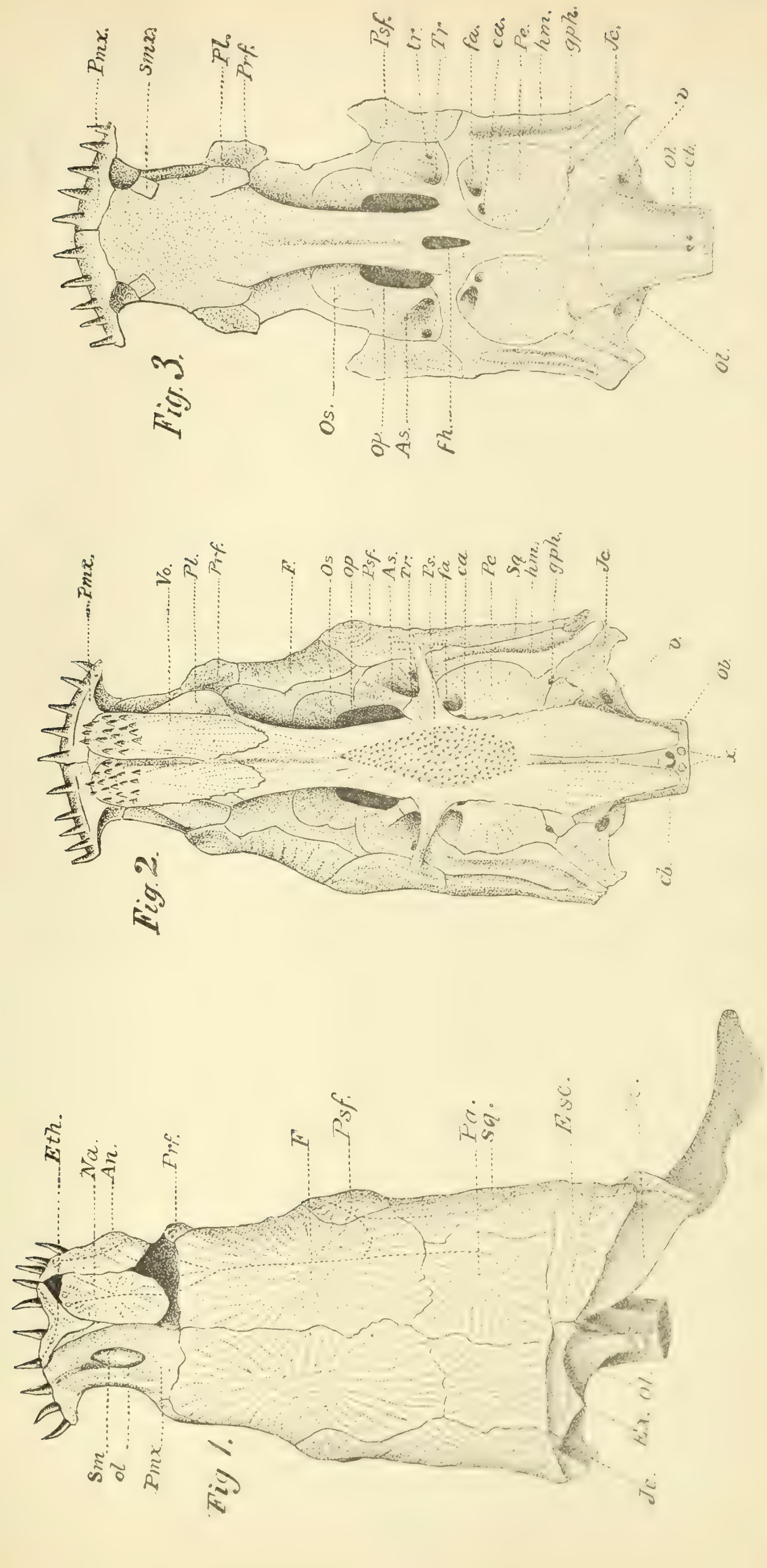


Fig 1.

Fig. 2.

Fig. 3.

PLATE II.

FIG. 4. The skull of *Amia calva* vertically bisected through the median line; same specimen; life size. (After Sagemehl.)

FIG. 5. The same; lateral view of the cranium before bisection. (After Sagemehl.)

FIG. 6. Primoidal cranium of *Amia calva;* same specimen as before, viewed from above after the removal of all the "cover bones;" life size. The cartilage tracts here are between the premaxillaries (*Pmx*); at *ol*; all the central portion and the lateral fossæ, *ta*. (After Sagemehl.)

FIG. 7. Superior view of the skull of *Amia calva,* with all the "cover bones" *in situ.* Life size. (After Franque.) The figures in this plate copied by Mr. H. L. Todd from the author's figures as given.

Fig. 4.

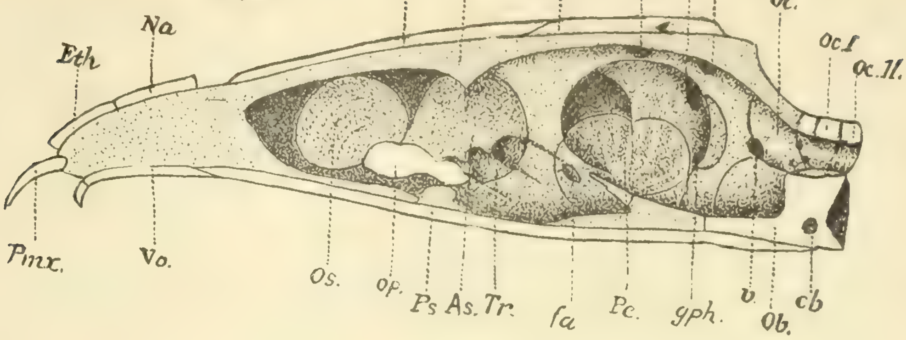


Fig. 5.

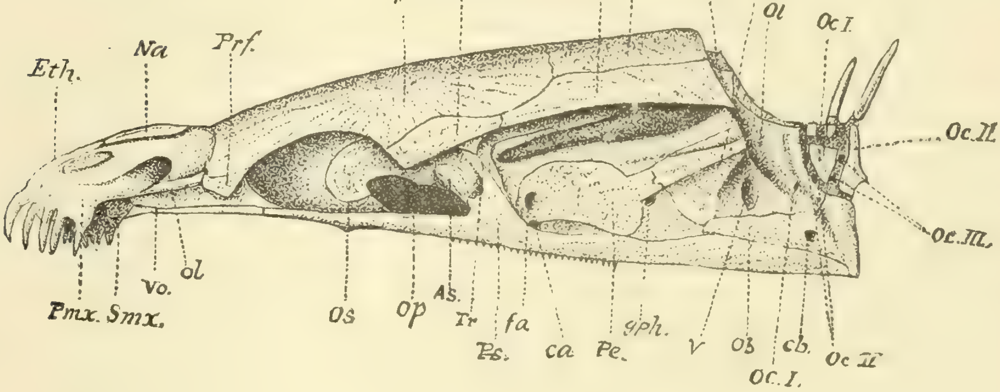


Fig. 6.

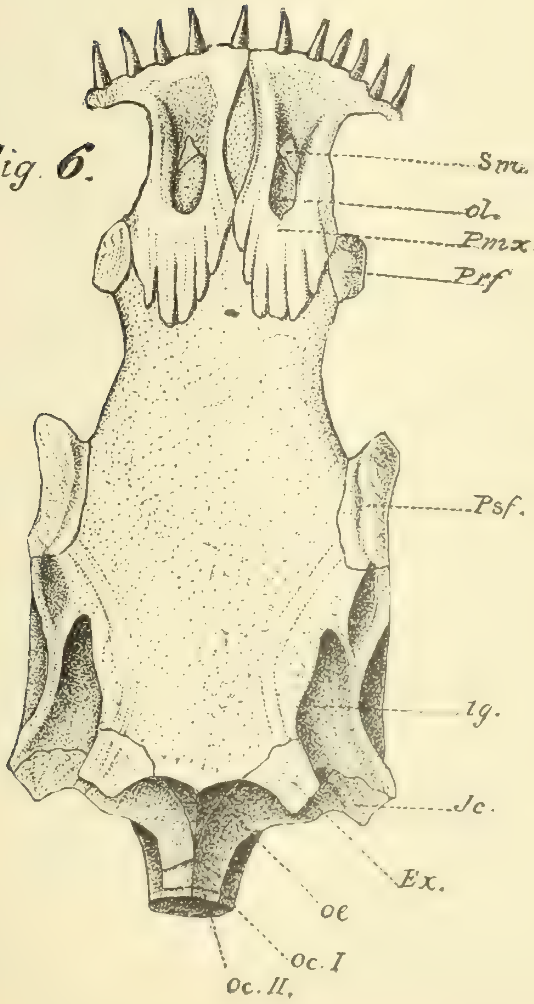


Fig. 7.

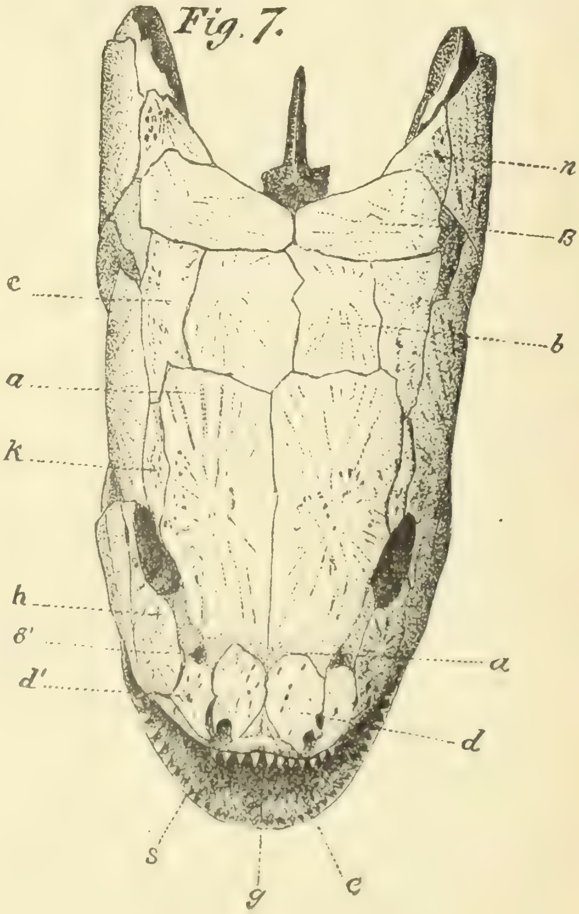


PLATE III.

FIGS. 8 and 9. Transverse sections through the cranium of *Amia calva* in the region of the nasal pits. Fig. 8 the anterior section, and they follow in sequence through Fig. 12. The sections are diagrammatic; with the cartilaginous parts stippled. (After Sagemehl.) Copied by Mr. H. L. Todd.

FIGS. 10, 11, and 12. Similar sections through the region of the optic foramen, the facial foramen, and the labyrinth region just anterior to the foramen for the glossopharyngeal, respectively. (After Sagemehl.) Copied by Mr. Todd.

FIG. 13. Posterior view of the cranium of the same specimen of *Amia calva*. Life size. (After Sagemehl.) Copied by Mr. Todd.

FIG. 14. Three vertebræ of *Amia calva*, magnified about three times, showing the method of articulation of the neural spines and the facets for the ribs. (After Franque.) Copied by Mr. Todd.

FIG. 15. Left lateral view of mandible of a Teleostean fish (*Micropterus salmoides*). Life size. Drawn by the author from his own dissections. The various bones pulled apart to show their entire shape.

Fig. 8.

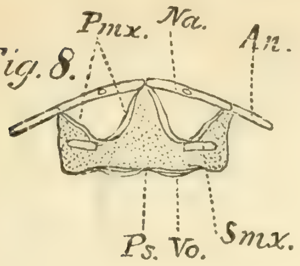


Fig. 9

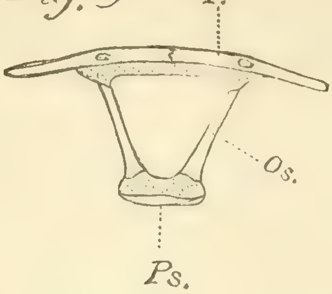


Fig. 10.

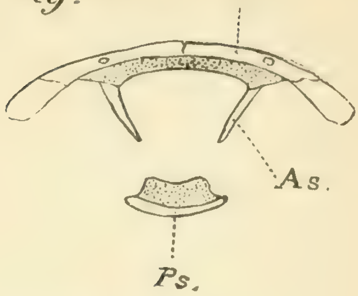


Fig. 11.

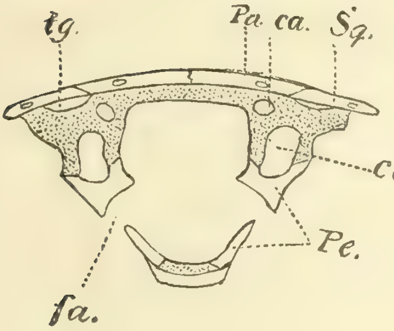
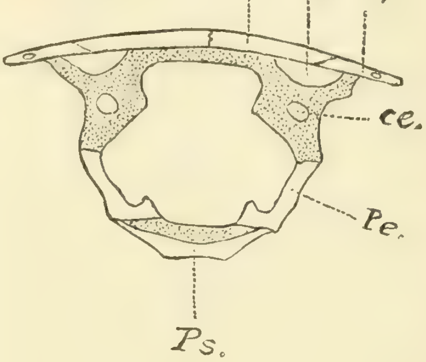


Fig. 12.



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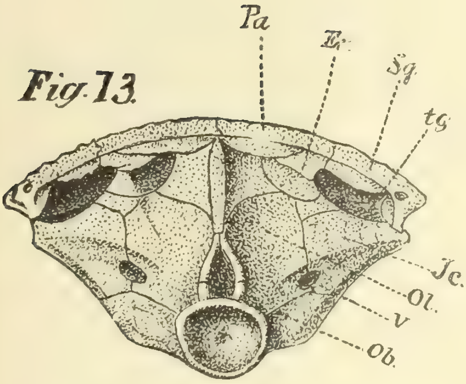

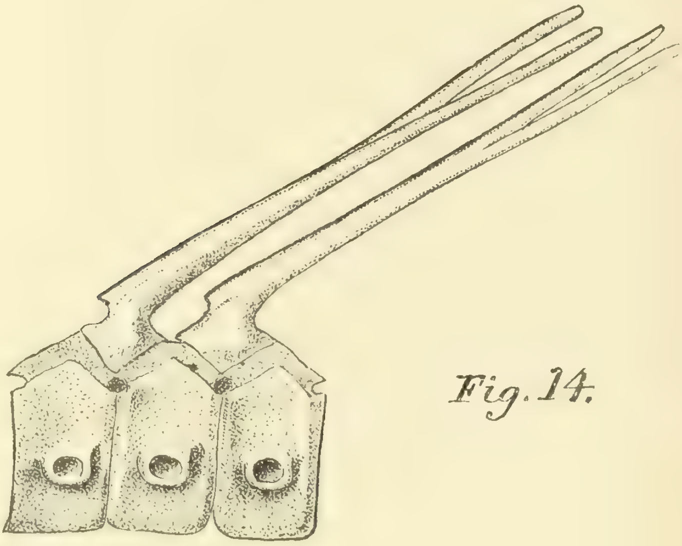

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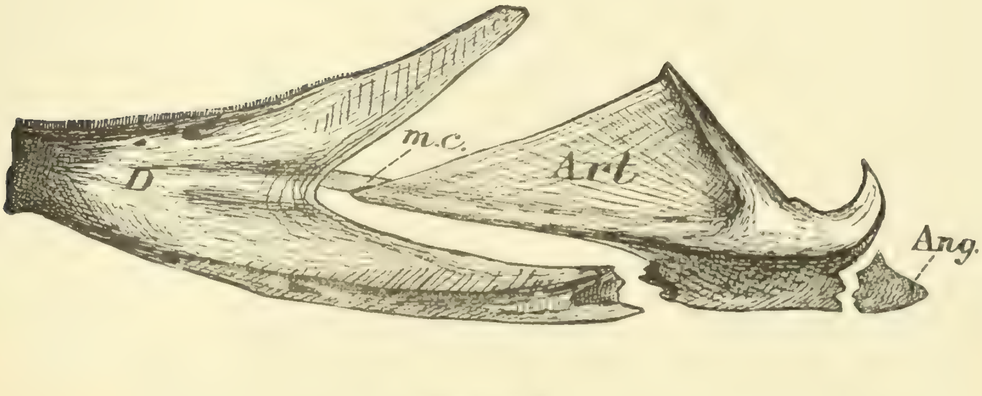
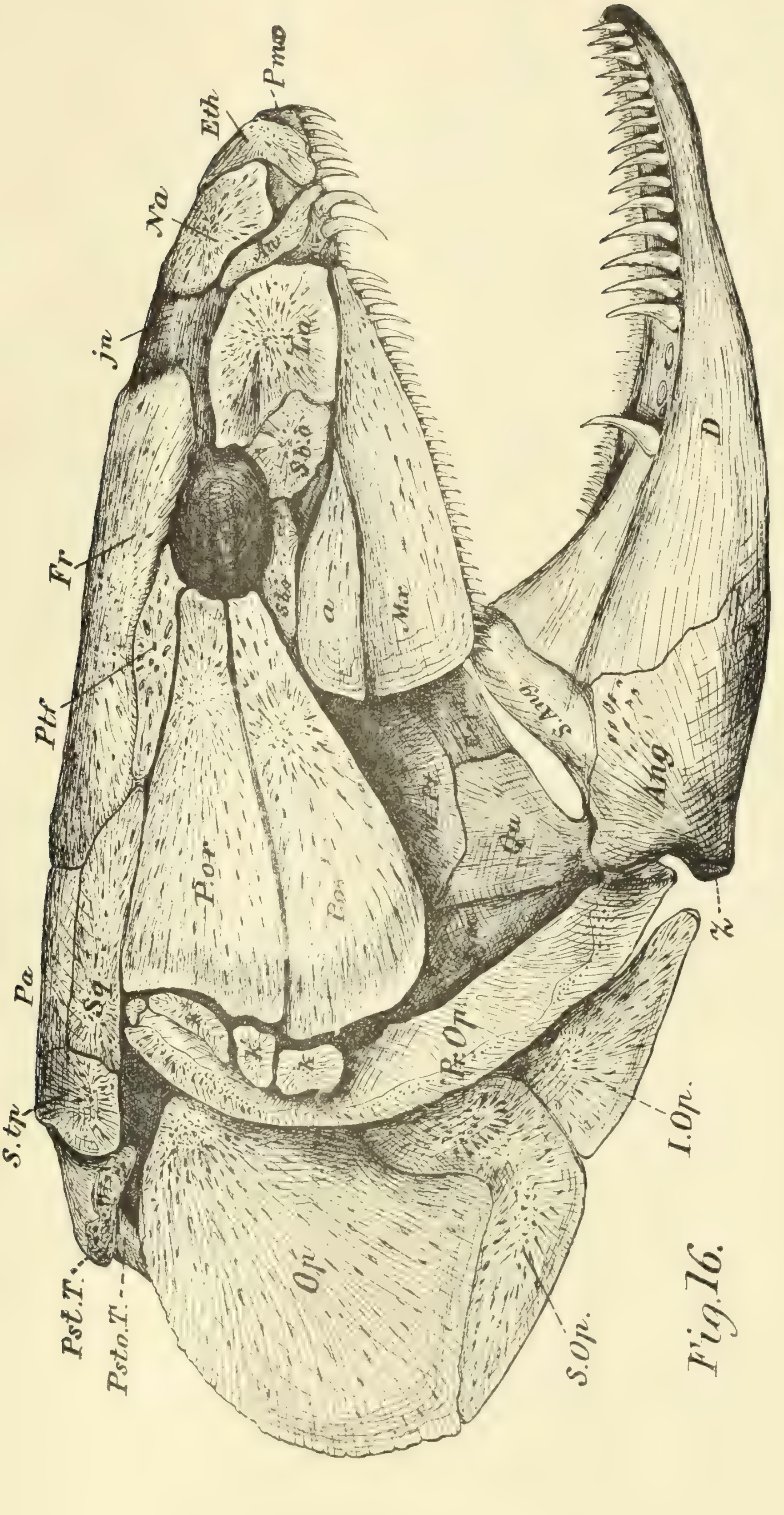


Fig. 15.

PLATE IV.

FIG. 16. Right lateral view of the skull of *Amia calva*, showing the arrangement of the Ganoid plates. Life size from nature, by the author. This specimen was collected by me near New Orleans, La., in 1883.


Pmx
Eth
Na
jn
La
S.o.o
Fr
Pt.f
a
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D
S.Ang
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Qu
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Pa
Sq
P.Op
S.tp
I.Op
z
Op
S.Op.
Pst.T.
Psto.T.

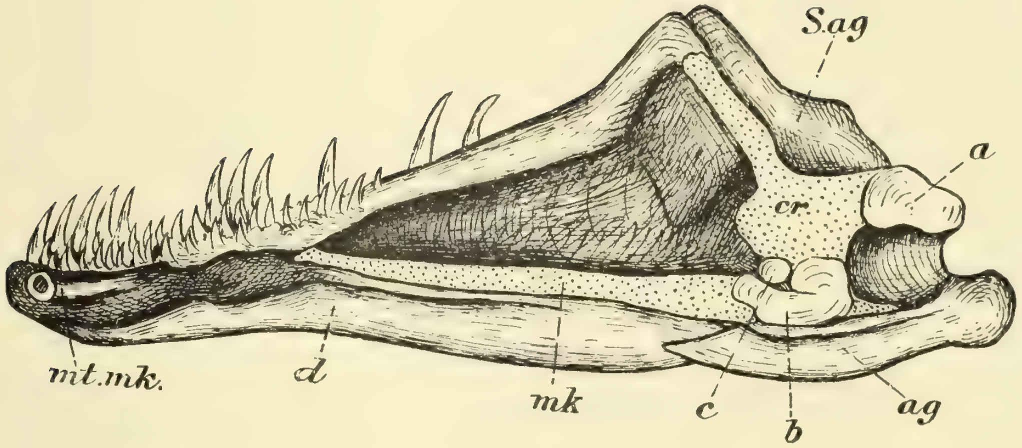
Fig. 16.

PLATE V.

FIG. 17. Inner aspect of the right half of mandible of *Amia calva*, the splenial element removed. (By the author, after Bridge, somewhat enlarged.)

FIG. 18. The same view from a specimen in my own possession; the splenial element *in situ*, together with the bones connecting it with the symphysis. Enlarged. (From nature, by the author.)

Fig. 17.



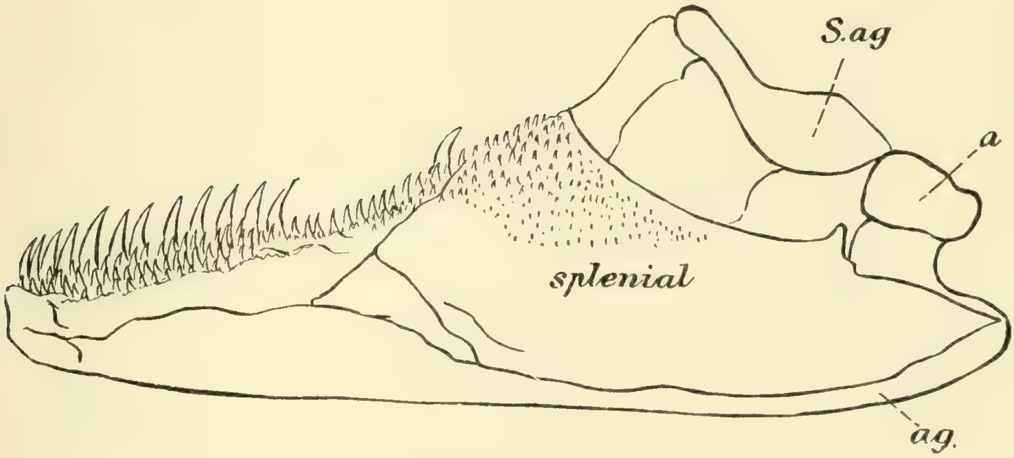


Fig. 18.

PLATE VI.

Fig. 19. The palatopterygoidean arcade of *Amia calva*, together with other associated bones and the hyoidean arch, to the outer side of which articulate the twelve branchiostegal rays, *Brs. R.* The dotted portions about the hypohyal, metapterygoid and epihyal represent cartilage, but all other cartilaginous and membranous portions have been carefully removed. This figure well shows the relation of the hyoidean arch to the other bones represented, as it does the position occupied by the semi-anchylosed preoperculum. Life size from nature, by the author.

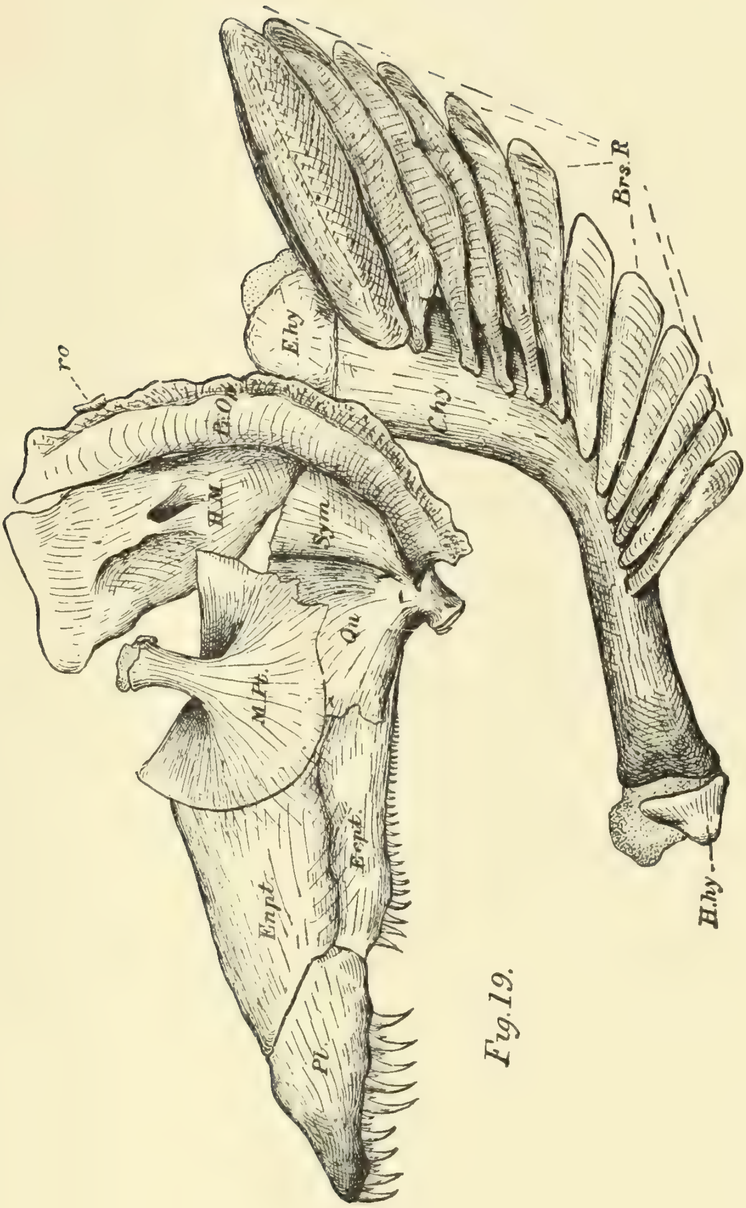
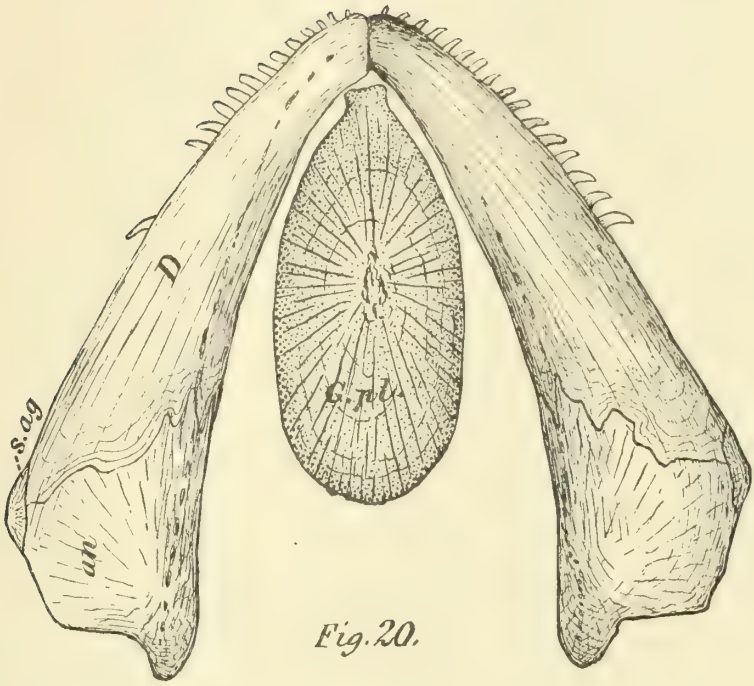


Fig. 19.

PLATE VII.

FIG. 20. Inferior aspect of the mandible of *Amia calva*, showing the normal position of the gular plate, *G. pl.* Life size from nature, by the author.

FIG. 21. A longitudinal, vertical, median section of the cranium of a perch (*Perca americana*), inside view showing the relations of the various bones, the position of the *otolith*, the eye-muscle canal, and the bones that enter into the ear capsule. Adult. Slightly enlarged from nature, by the author, from his own dissections.


D
s.ag
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G.plt

Fig. 20.

Fig. 21.

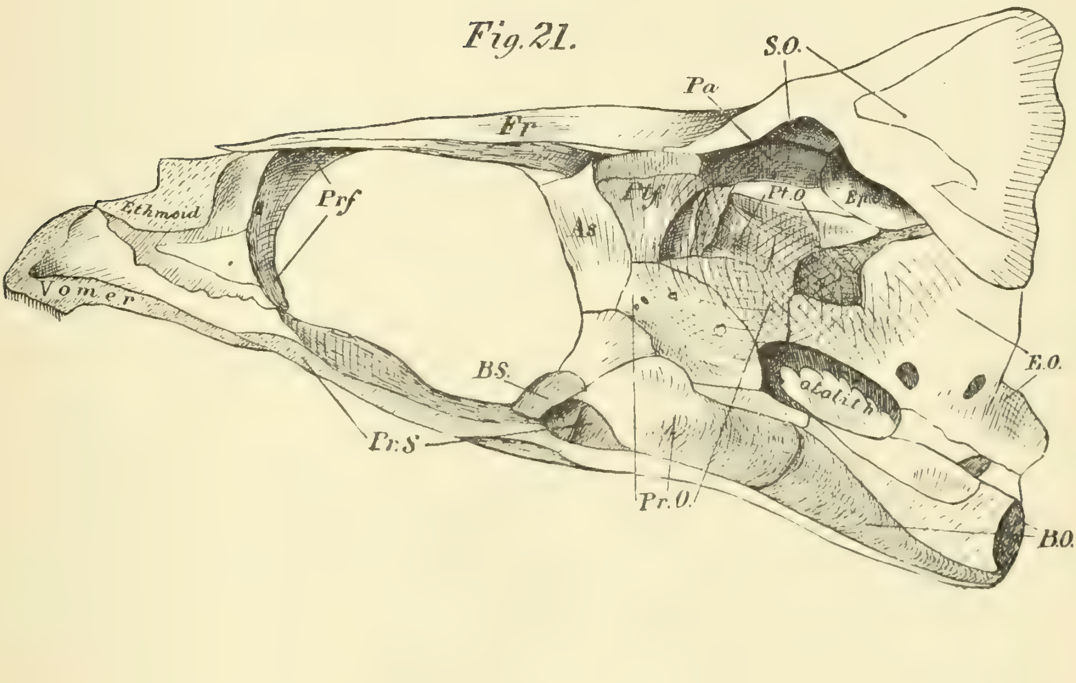

S.O.
Pa
Fr
Prf
Ethmoid
Vomer
As
Pt.O
BS.
otolith
E.O.
Pr.S
Pr.O.
B.O.

PLATE VIII.

Fig. 22. The left outer aspect of the upper jaw of a teleostean fish (*Micropterus*), together with the bones associated with it. These latter are slightly dislodged from their normal positions, the better to show their relations. Life size from nature, by the author, from his own dissections.

Fig. 23. Inner aspect of left half of shoulder girdle and pectoral limb of *Micropterus salmoides.*

Fig. 24. Same view of like parts in *Amia calva.* Both figures reduced one-fourth. From nature, by the author.

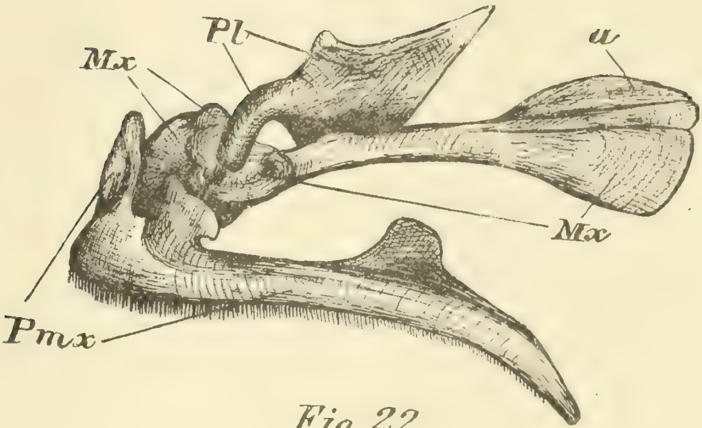


Fig. 22.

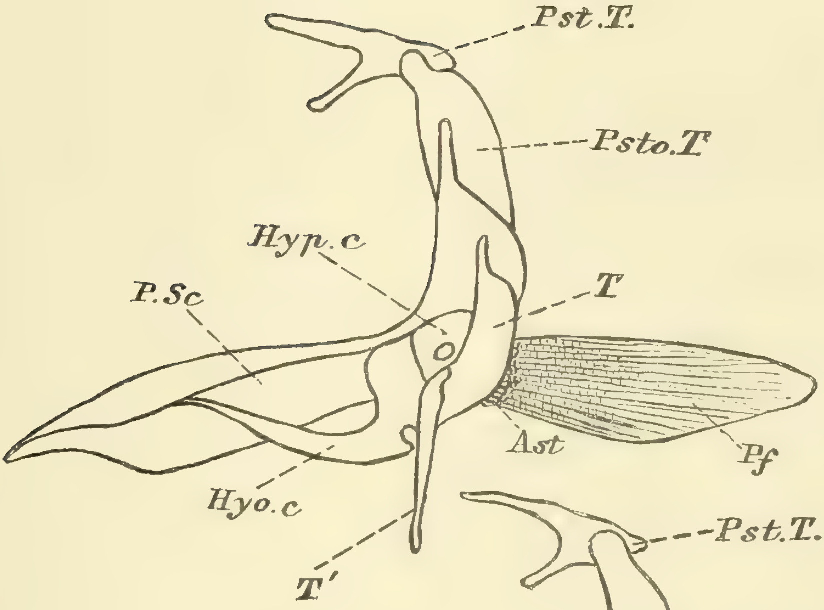


Fig. 23.

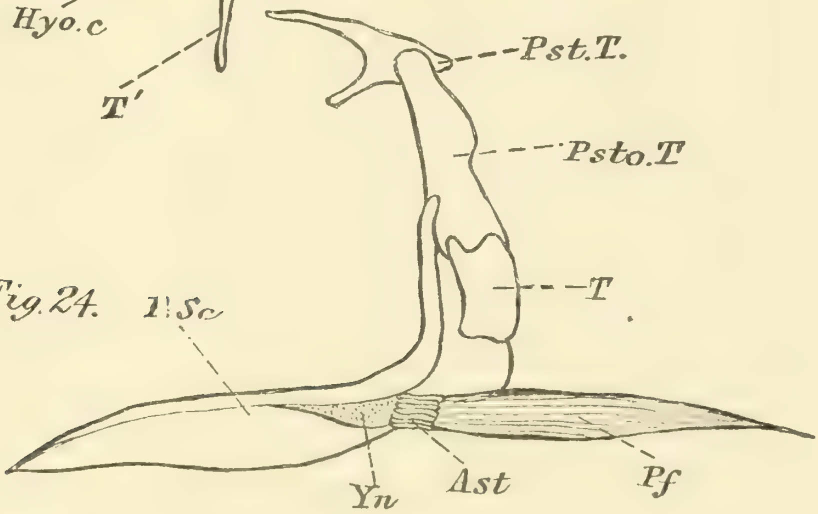


Fig. 24.

PLATE IX.

Fig. 25. The skeleton of the caudal extremity of *Amia*. The five small rods of bone, referred to by the letters *jf*, are the continuation of the interneural spines. These have not been previously described, and were overlooked by Franque, consequently do not appear in his figure. Taken in connection with the free spines found over the anterior vertebræ of the column, these bones rather lead me to believe that in the early ancestors of *Amia* the fin was continuous, from base of cranium to include the tail. Life size from nature, by the author.

Fig. 25.

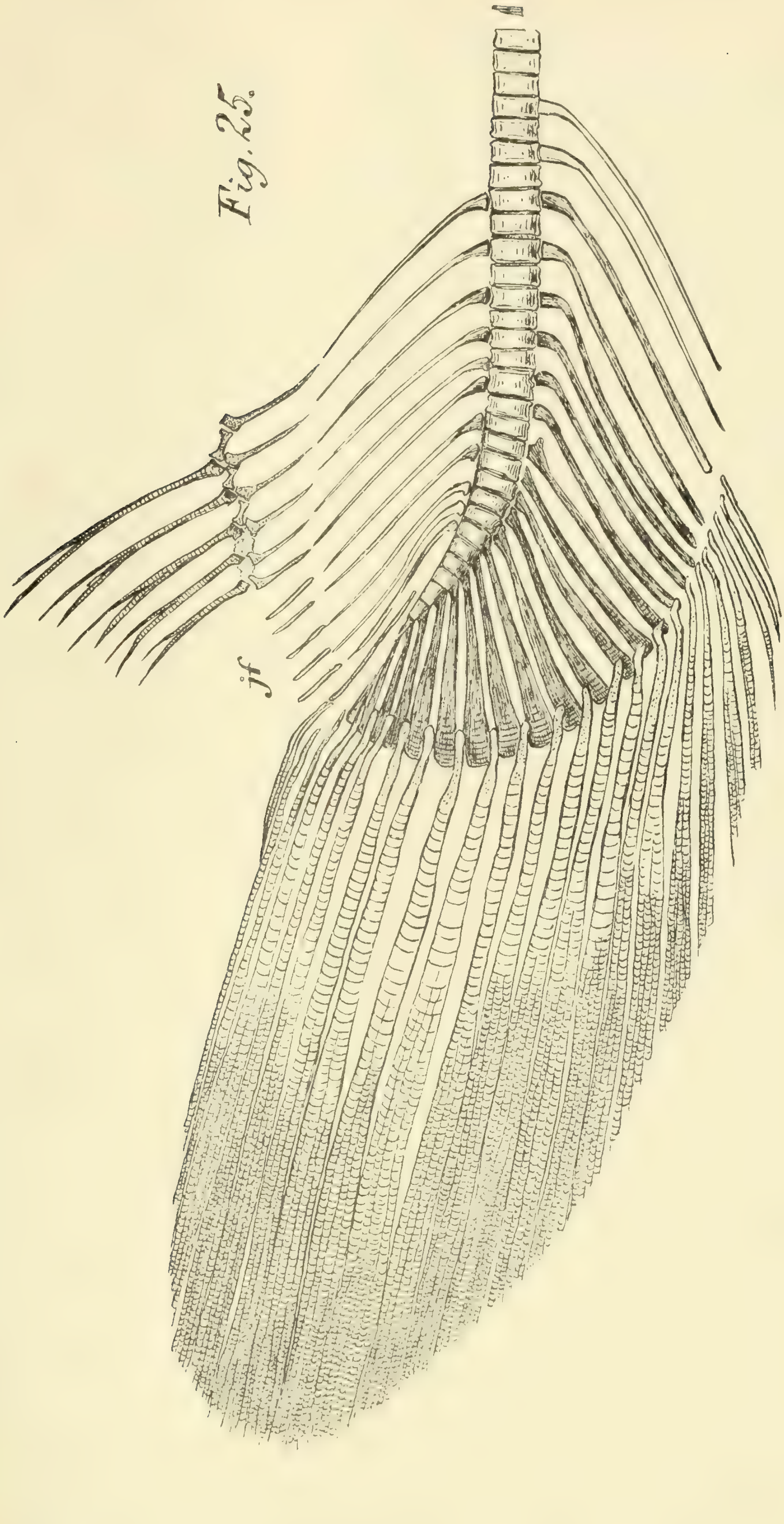


PLATE X.

FIG. 26. Left lateral view of the skeleton of *Amia calva*. Copied by Mr. H. L. Todd from Franque's figure and considerably reduced.

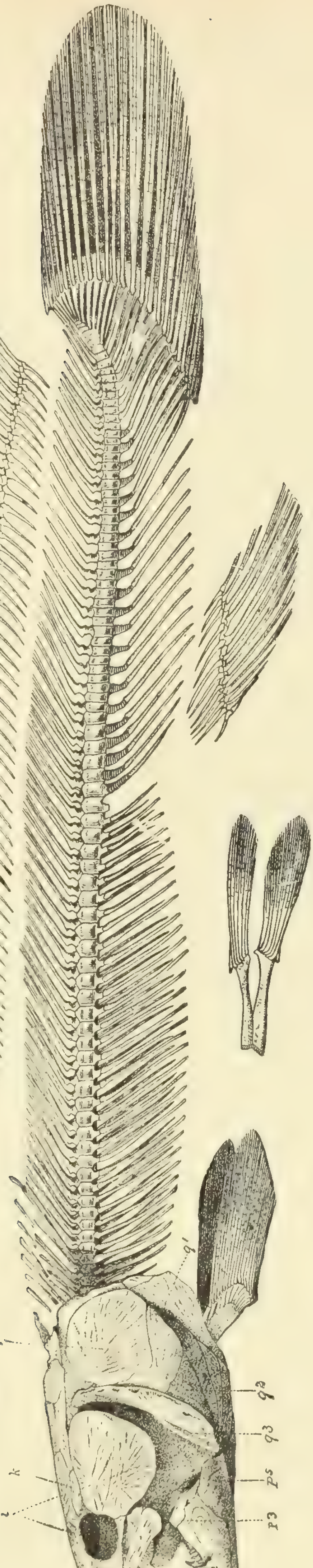


Fig. 26.

PLATE XI.

FIG. 27. Left lateral view of the skull of *Micropterus salmoides*, with the skeleton of other parts connected with it posteriorly. This figure is designed to show the relation of the bones, arranged *in situ*, of this part of the skeleton in a typical teleostean fish. Life size from nature, by the author, from his own dissections.

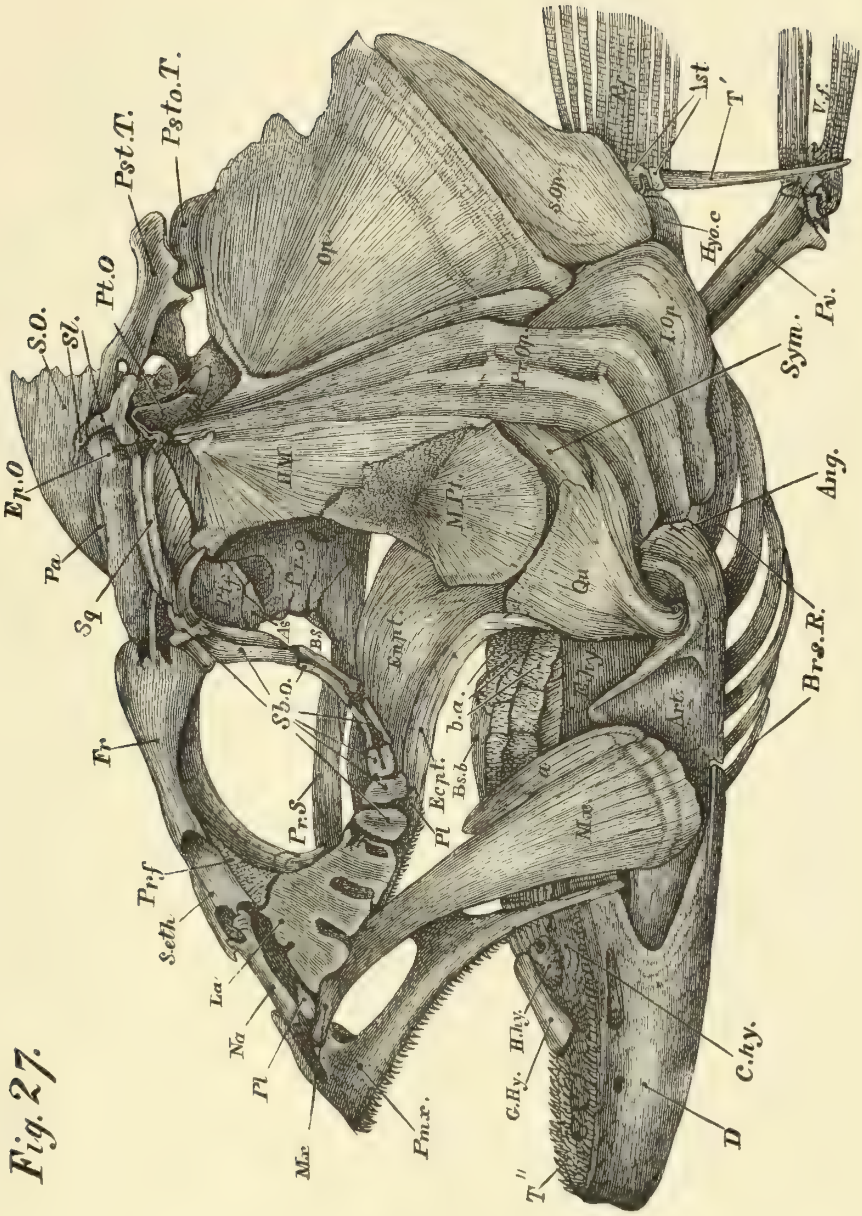

S.O.
Sl.
Pt.O
Pst.T.
Psto.T.
Op.
S.op.
1st
T'
V.f.
Hyo.c
Pv.
Sym.
I.op.
Pr.Op.
Ang.
Brs.R.
Ep.O
Pa
Sq
Fr
Sb.o.
Pr.S
Prf
Seth
La
Na
Pl
Mx
Pmx.
Ecpt.
Bs.b.
b.a.
Art.
Qu
M.Pt.
Enpt.
C.hy.
D
H.hy.
G.Hy.
T''

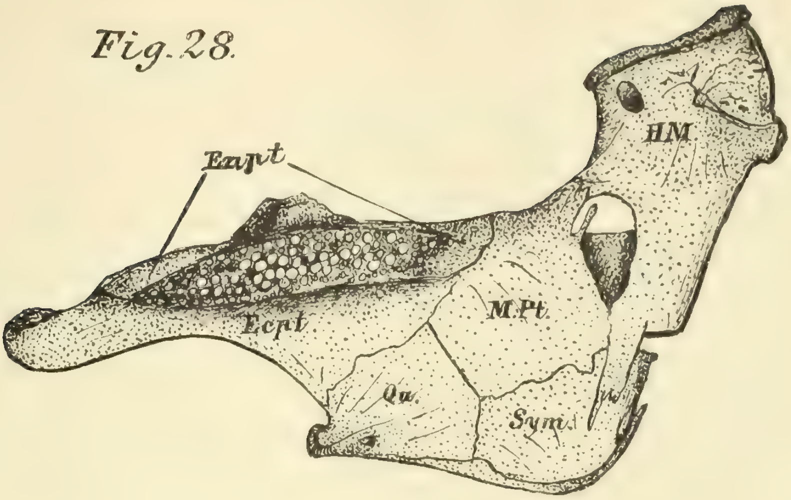
Fig. 27.

PLATE XII.

FIG. 28. Palatoquadrate arch, nearly complete, right side, inner aspect, of *Albula vulpes*. Same specimen as shown in Fig. 29. The area of teeth are seen just above the letters *Ecpt.* Life size. Drawn by the author from a specimen kindly lent him by Prof. Theodore Gill, from his private cabinet.

FIG. 29. Right lateral views of cranium of *Albula vulpes*, and the greater part of the palatoquadrate arch. Same specimen as figured in Fig. 28. Life size from nature, by the author, from the specimen in Professor Gill's cabinet.

Fig. 28.


Enpt
HM
M.Pt.
Ecpt
Qu.
Sym.

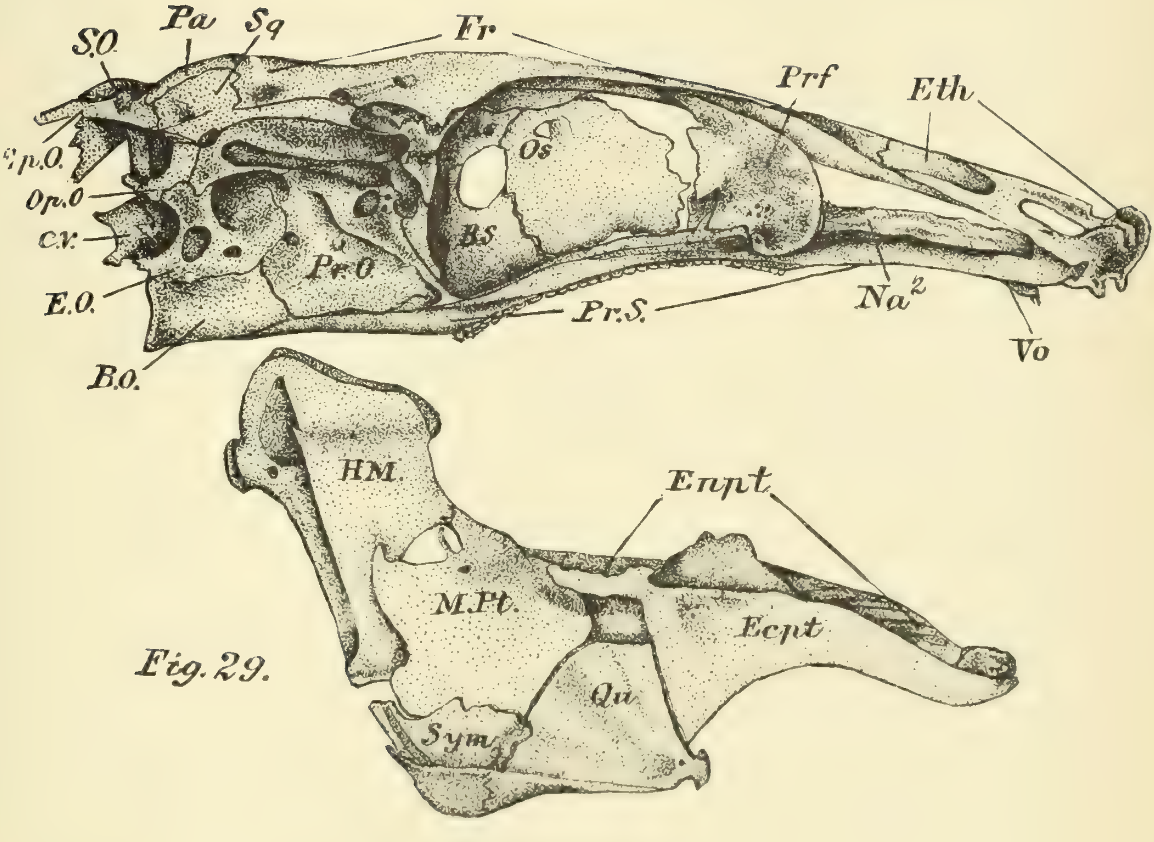

S.O.
Pa
Sq
Fr
Prf
Eth
Op.O
C.V.
E.O.
B.O.
Os
BS.
Pr.O
Pr.S.
Na2
Vo
HM.
Enpt.
M.Pt.
Ecpt
Qu
Sym

Fig. 29.

PLATE XIII.

FIG. 30. Superior view of the cranium of *Albula vulpes*. From the same specimen of which the lateral view is shown in Fig. 29 of this paper. Life size from nature by the author.

FIG. 31. Inferior view of the cranium of *Albula vulpes*. The elliptical area of teeth are here seen upon the parasphenoid, *Pr. S.* Same specimen as in Fig. 30, from Professor Gill's collection. Life size, from nature, by the author.

FIG. 32. Inner aspect of opercular bones, hyoid, symplectic, and other elements of *Micropterus salmoides*. Left side. Designed to show the relations of these parts as found in a typical teleostean fish. Life size from nature; drawn by the author from his own dissections.

PLATE XIII.

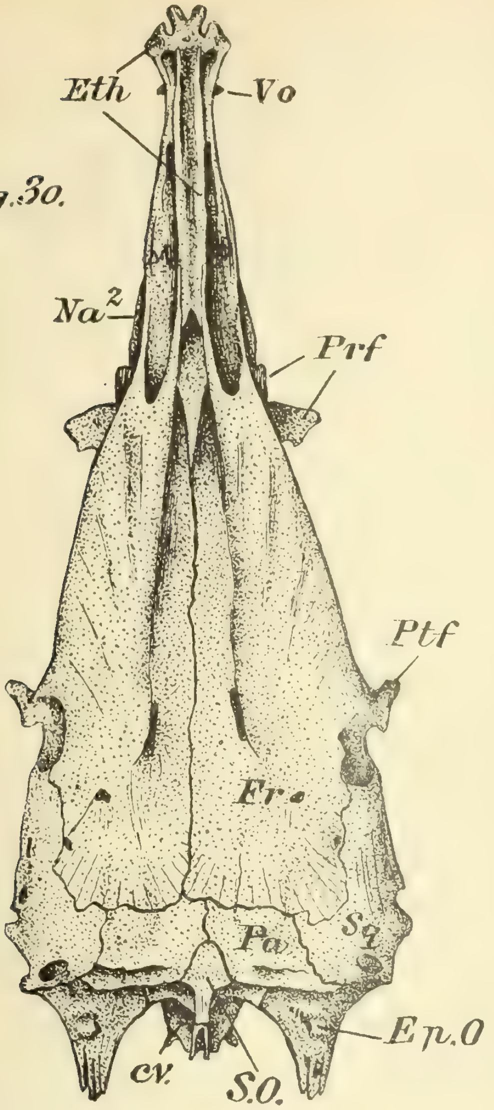


Fig. 30.

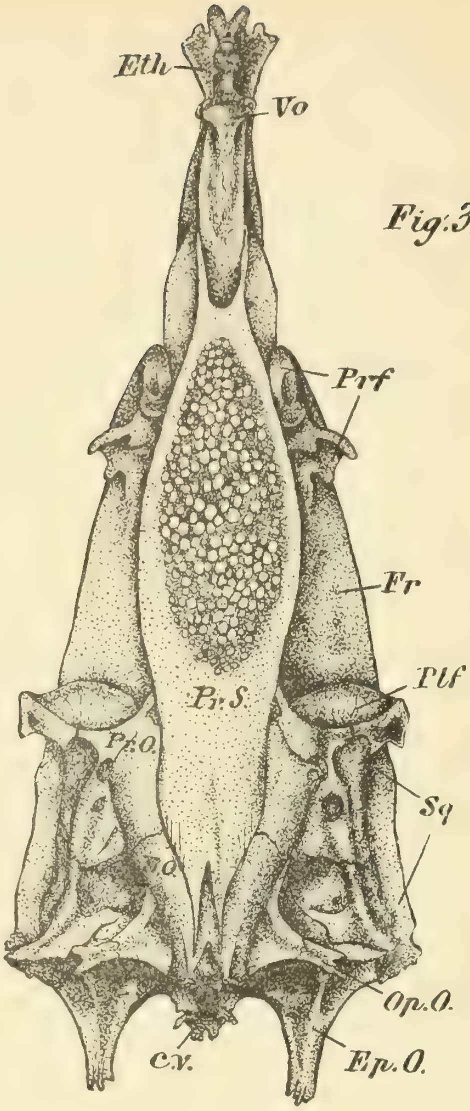


Fig. 31.

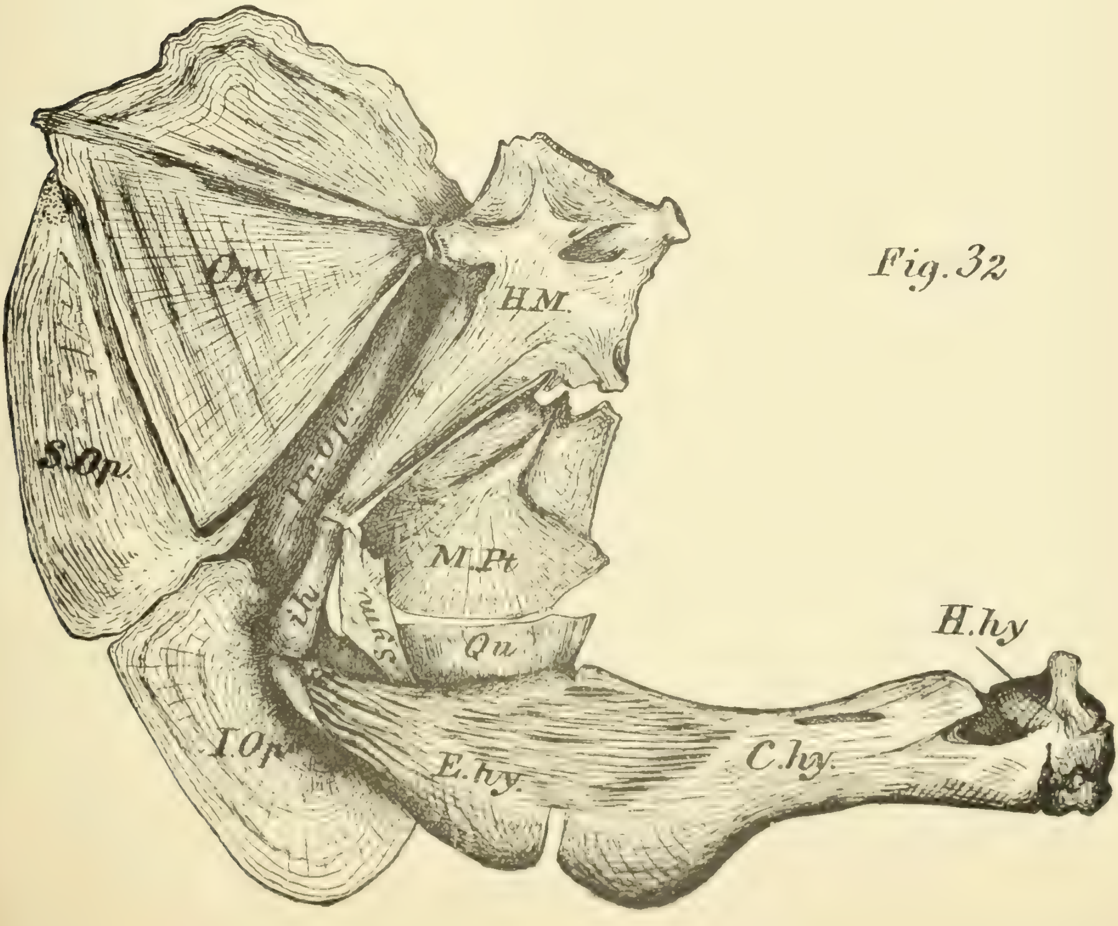


Fig. 32

PLATE XIV.

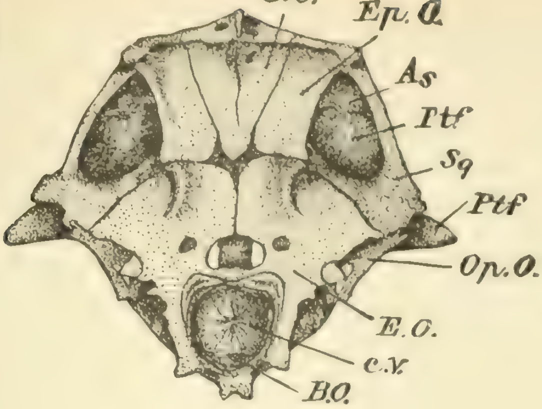
Fig. 33. Posterior view of the cranium of *Megalops*. The first vertebra of the col umn is anchylosed with the basioccipital, and is referred to by the letter *c. v.* Life size.

Fig. 34. Right lateral view of the cranium of *Megalops*. Missing parts are seen fron this aspect, as the parietals and basisphenoid. The normal position o this cranium would have the parasphenoid, *Pr. s.*, in the horizontal plane but it is represented this way to save space. This specimen is the same a seen in Fig. 33, and both were drawn by the author from a specimen kindl lent him by Professor Gill from his private cabinet.

Fig. 35. Outer aspect of part of shoulder girdle, and the pectoral fin of *Micropteru salmoides*. Life size. Drawn by the author from his own dissections.

PLATE XIV.

Fig. 33.



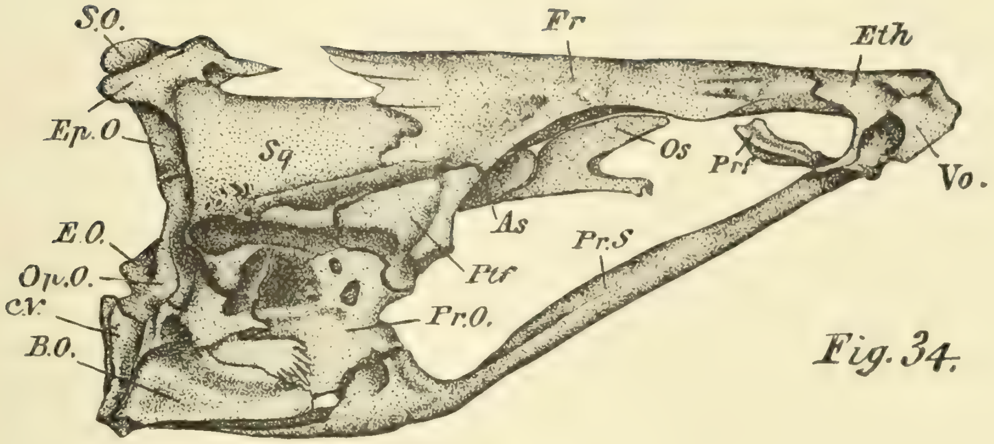
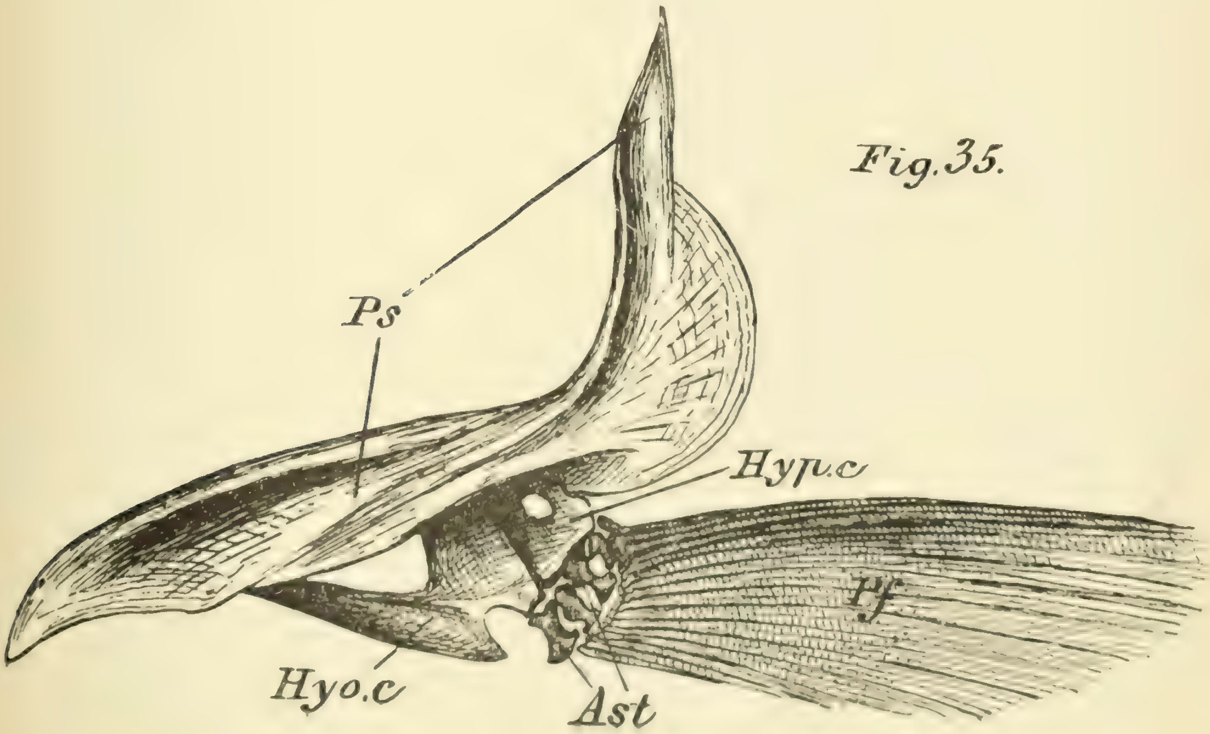


Fig. 34.

Fig. 35.



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XX.—OLIGOCHÆTOLOGICAL RESEARCHES.

By Gustav Eisen.

INTRODUCTION.

In the beginning of the present year (1879) I had the honor to present to the Academy of Sciences of San Francisco, Cal., and also to the Royal Academy of Sciences of Stockholm, Sweden, preliminary reports on the same subject of which I now propose to treat more extensively. Neither of these reports, however, is as yet published, and this will explain why in the following no mention of them has been made, and no citations from them quoted.

The theories advanced in them I have had little opportunity to change. Only in few instances have further investigation and access to a greater number of specimens necessitated any material modification of my former views, and whenever any such change has been made, I have always called special attention to the same.

My investigations have been confined principally to the characterizing of the species and to the anatomical structure of the generative organs. The following treatise, therefore, has no pretension to being exhaustive, even if such a word could properly be applied to any work in natural science; but, on the contrary, I must freely confess that many an important point pertaining to this subject has here been only lightly touched, or even not at all enlarged upon—mostly the result of a limited time and library.

The many new forms here described for the first time may perhaps to some degree compensate for the above defect, and, as I trust, call a more general attention among zoologists to the fresh-water oligochæta —a class which, I am sure, will in the near future be found to contain thousands of forms.

My field of investigation has been limited to Sweden and California, and in both countries to comparatively few localities.

In the following I propose first to give a description of all the species found by me, and afterwards to treat more minutely of some points in their anatomy and physiology.

A.—DESCRIPTION OF THE SPECIES OF TUBIFICIDÆ.

Oligochætous, limicolide worms, with spines in fascicles, of which four in each segment. One ventral and one dorsal longitudinal vessel, the latter of which is pulsating. Both vessels are connected by transversal gastric or perigastric vessels. Receptacles of the spermatozoa, two in the ninth setigerous segment. Efferent ducts, two in the tenth setigerous segment. Each duct furnished with only one efferent funnel. The oviduct is invaginated by the penis. Habitat: Fresh or brackish water. Two subfamilies, viz:

Telmatodrilini: Atrium furnished with several prostata glands; penis and penis sheath united at apex.

Tubificini: Atrium with a single prostata gland; penis and penis sheath not united.

I.—*Sub-fam.* TELMATODRILINI, *nov. fam.*

Atrium is surrounded with several prostata glands, not connected with each other.

The penis is connected with the penis sheath at its exterior apex.

Oviduct is large, muscular, and opaque.

The receptacle is situated in the ninth and the efferent duct in the tenth setigerous segment.

Nervous system.—The two longitudinal parts of the ventral nerve trunk are connected by anastomosing, minute commissures.

The spines resemble those of *Enchytræidæ* in general form, but are more numerous in every fascicle and all of the same length. In young specimens they are indistinctly forked.

Of this family as yet only one species and genus is known, viz:

Gen. TELMATODRILUS *nov. gen.*

No distinctly pulsating or differentiated hearts, but the secondary vessels in the sixth to tenth setigerous segments are indistinctly pulsating, without having the shape of distinct hearts. The ventral vessel is not strictly ventral, but pushed towards the dorsal side of the body, and so near to the dorsal vessel that both seem to run close together; the ventral vessel not pulsating, the dorsal vessel pulsating.

Only one species is as yet known, viz:

TELMATODRILUS VEJDOVSKYI *nov. sp.*

(Pls. I and II; Figs. 1*a* to *k*.)

Vascular system.—The ventral vessel is forked in the fourth setigerous segment. The transversal or secondary vessels are of two kinds in every segment, viz, gastric and perigastric. The perigastric vessel is situated close to the posterior end of the segment; it sends to the integument of the body numerous minor tertiary vessels, forming together

a dense dermal vascular net. The gastric vessel embraces the alimentary canal at the middle of each segment; its many minute, tertiary side branches form a dense gastric vascular net.

The perigastric vessels in the sixth to tenth setigerous segments form a kind of weakly pulsating heart, however without being distinctly differentiated. The largest pair is found in the tenth setigerous segment, the smallest in the sixth segment. The perigastric vessels forming the hearts are extremely long and relatively narrow, being thickest near the dorsal vessel, and from there gradually decreasing in size towards the ventral vessel. The blood is yellowish red.

Nervous system.—The cerebral ganglion is very unlike that of *Tubificini;* nor does it in fact resemble that of any other known *Limicolide.* Its general shape is somewhat triangular, furnished with a large posterior projection. Its sides are concave, with two anterior projections towards the cephalic lobe. The ventral ganglion emits one pair of nerves in each segment; its swelling in each segment is inconsiderable.

Gastric system resembles that of *Tubificini* to a great extent. The œsophagus is long and narrow, extending to the eleventh segment; is from here considerably elongated and forming the commencement of the intestine, which is here hyaline, not furnished with hepatic cells. In the fifteenth segment the canal contracts considerably, and is from here to the end of the body covered with dark brown, glandular, hepatic cells.

Generative system.—Efferent duct, atrium, and penis are well characterized. The efferent duct is unusually narrow; its interior end is gradually increasing in size, forming a pear-shaped funnel. A bundle of spermatozoa is often found in its opening, considerably protruding, as is the case in *Enchytræidæ.* The atrium is crescent-shaped, cylindrical, and furnished with a set of about ten or more globular and well-defined prostate glands, surrounding the atrium on all sides. Both atrium and penis consist of two different layers. The prostate glands and also the efferent duct are apparently developed from the interior one of these layers. This explains why the atrium in *Tubificidæ* is "double," as it has been described by Claparède,* Udekem and others (Pl. I, Fig. 1*e*). This exterior coat of the atrium was originally only a continuation of the oviduct, and is so yet in the younger stages of the worm. (About this see further ahead in this paper.)

The penis is large, its upper part being of somewhat the same shape as the atrium. Its lower end is first somewhat swelled and afterwards immediately tapering, forming a real external penis. This external part of the penis is furnished with a funnel-shaped penis sheath (Fig. 1*c*, p. sh.). But, contrary to what is the case in *Tubificini*, this sheath is connected with the apex of the penis. The same is the case with the penis sheath in undeveloped specimens of *Tubificini*, but as the worm develops is the sheath wholly separated from the apex (Fig. 18 *c*, *d*, *g*, *h*). The penis consists of two layers; the interior one is a continuation of the inner-

* *Recherches Anotomiques*, p. 23, and others.

most layers of the atrium. The exterior one, of the second layer of atrium. The third layer of the atrium is not in continuation with the layers of the penis. The penis sheath is very pellucid, and difficult to discover; especially so is its upper margin. Its lower interior sides are covered with numerous diagonal muscles, one end of which is attached to the body of the penis. In the center of both atrium and penis is found a continuous row of spermatozoa. The penis is only external in fully matured specimens.

The oviduct consists of a heavy muscular coating or sack, one end of which is attached to the body wall, the other free in the neighborhood of the lower end of the atrium. This oviduct is extremely heavy which makes it often impossible to discover the nature of the organ covered by the same.

The testes consist of two oblong amorphous bags, situated in the eighth and ninth setigerous segments, one on each side of the ventral nerve.

The ovaries consist of two rounded, sack-like bodies, situated between the ninth and tenth segments, their anterior ends being attached to the body wall of the ninth segment and part of their body to the dissepiment between the ninth and tenth setigerous segments. The ripe ova are always found in the broadest end of the ovary, the smallest or least developed ones in the narrowest part of the same (Fig. 1*g*).

The receptacle consists of two minute oblong sacks, one on each side of the ventral nerve in the ninth setigerous segment. Their exterior porus is found on the body wall between and somewhat in front of the ventral fascicles, not in front of one of them, as in *Tubeficini.*

No spermatophores are found in this species, the spermatozoa being simply agglomerated together in pear-shaped or globular balls. In the atrium they form a continuous row in the middle of the inmost cavity (Fig. 1*e*, spz).

The segmental organs resemble those of *Tubificini* in their general structure. The whole tube of the organ is surrounded by large pellucid cells, sometimes of a globular, sometimes of a more oblong shape (Fig. 1*h*). In the majority of these a large nucleus is plainly visible. The above cells are found not only surrounding the segmental organs in front of the efferent duct, but also on those behind the same.

The exterior aperture of the organ is the largest one, and from here the tube tapers gradually towards the interior aperture, at the lower end of which is found two sack-like appendices. The aperture is strongly ciliated (Fig. 1*i*).

The integument of the body is very thick, and the body accordingly not very flexible. The worm, when found, therefore, resembles more a small pointed stick or straw, the tail being the most flexible part of the animal. In this respect this worm is unlike most of the other species of *Tubificidæ*, which, with few exceptions, are lively and very movable animals.

Body.—The length of the same in alive specimens is generally from 35^{mm} to 50^{mm}, and the width between 1^{mm} and 2^{mm}. The anterior part

is the thickest, the body gradually tapering towards the posterior end. The color of the body is fleshy, brownish red, rather opaque, with the vascular system plainly visible.

Setæ are found, as usual, in the family, in four fascicles in every segment, every fascicle containing numerous, or from eight to fifteen, spines. These are in adult specimens entire, considerably curved, and, generally speaking, not unlike those found in *Enchytræidæ*. In young specimens the spines are found to be indistinctly forked (Fig. 1*d*).

Habitat.—California, Sierra Nevada, in Fresno and Tulare Counties, at an altitude of from 6,000 to 10,000 feet.

It lives in the marshy meadows, and is sometimes found in decaying wood, sometimes again in the bottom mud, most frequently where the water is very shallow. In small hollows, where manure has been deposited, this worm is most certain to be found; in poor ground it will, with certainty, be looked for in vain.

This worm is decidedly of a nightly habit. In day-time it is never found above the ground, but in night-time its tail is always seen protruding in the water above the same.

Adult specimens found in August and later.

II.—*Sub-fam.* TUBIFICINI.

KEY TO THE GENERA.

I.—More than one kind of spines present, viz, hair spines, comb-like spines, and forked spines, two of which kinds are always present (except Hemitubifex.)

A. The cephalic ganglion anteriorly furnished with a large conical processus. Spermatophores extremely long and spirally coiled. Oviduct single.

SPIROSPERMA.

B. The cephalic ganglion is not furnished with an anterior processus. Spermatophores short and broad, not spiral.

a. The efferent duct is comparatively short and broad, not longer than the atrium and copulative organs together.

ILYODRILUS.

b The efferent duct is comparatively long and narrow, always longer than the atrium and copulative organs together.

1. The base of the receptacle is furnished with glands. Efferent duct or atrium furnished with *a* (*a* and *c*) "vesicula seminalis." Hair spines and forked spines, but the former not always present. No comb-like spines. The middle part of atrium is glandular.

HEMITUBIFEX.

2. The base of the receptacle is not furnished with glands; a "vesicula seminalis" present. The middle part of the atrium not glandular. Three kinds of spines always present.

PSAMMORYCTES.

3. The base of the receptacles not furnished with glands. No "vesicula seminalis." Two kinds of spines always present, viz, hair spines and forked spines.

TUBIFEX.

II.—Only one kind of spines, viz, forked spines.

1. Penis and oviducts not surrounded by spiral muscles. LIMNODRILUS.

2. Penis and oviduct surrounded by spiral muscles. CAMPTODRILUS.

Gen. SPIROSPERMA *nov. gen.*

(Pl. II and III; Fig. *a* to *g*.)

The cephalic gangloin is furnished with a large conical frontal processus, which does not branch itself in the cephalic lobe.

The posterior margin is concave.

The spermatophores are long, narrow, and spirally coiled.

The spines are of three kinds, viz, hair spines, forked spines, comb-like spines.

The integument is covered with dark, convex papillæ.

The whole of the atrium is glandular, no vesicula seminalis, and no glands at the base of the receptacle. Of the forked spines we can in reality distinguish four varieties, with from two to four prongs. This genus is one of the best characterized in the family. As yet only one species known, viz:

SPIROSPERMA FEROX, *n. sp.*

Nervous system.—The cephalic ganglion is cordate, conical in front, emarginated behind. The conical part is about as long as the rest of the ganglion. The posterior side-lobes are well rounded. The ganglionic cells are comparatively numerous and closely packed. (*Fig.* 2 *g.*)

Generative system.—The efferent duct is long and narrow, resembling that of other genera except *Ilyodrilus.* The atrium is crescent-shaped, its lower end long and narrow, and in some specimens terminating in a helix-like swelling, situated immediately at the upper end of the penis proper (*Fig.* 2*h*, *h. s.*). Penis proper has the form of a long and broad cylinder, somewhat contracted at the middle, and with the lower end terminating blunt. The upper half of the penis is surrounded by a chitinous penis sheath, the upper and lower openings of which are nearly of the same size. That part of the penis which is covered by the sheath is of different structure than the lower free part. While the former seems to be merely an unmodified part of the atrium proper, and consisting of numerous small, massed cells, the latter, on the contrary, is found to consist of very large, often angular cells, more regularly arranged. The oviduct consists of a large, narrow-walled tube, or rather sack, as it seems more muscular than chitinous, inclosing the penis and its sheath to their whole length. Exteriorly the oviduct is surrounded by longitudinal muscles, connecting the same to the body wall (*Fig.* 2*h*, msc.). The receptacles are of an enormous size, extending through

several segments. Its main vesicle is oblong and sack-like, supported on a stem of its own length. The receptacle contains a few (two to three) spermatophores of unusual form and size. The latter can nearest be compared with the tongue of a moth, when coiled in a spiral. It is nearly cylindrical, slightly thicker at the middle, with both ends considerably tapering and pointed (*Fig. 2i*). When more highly magnified it is seen to be divided in large diagonal segments of nearly equal size (*Fig. 2k*). The tails of the spermatozoa are seen to be protruding all along the upper third of the whole length of the spermatophore, the other two thirds being perfectly smooth (*Fig. 2i*). The ovaries are large, oblong bodies, with the ripe ova situated at the free extremity. The interior of the ovary contains undeveloped ova of different sizes, mixed. The smallest ones are not always found nearest the point of attachment to the dissipiment (*Fig. 2f*).

Segmental organs consist of long and narrow tubes, not covered with any globular cells. At different places we find the tube enlarged, forming large more or less circular chambers, which, however, are not further differentiated (Fig. 2*g**). Such chambers I have also found in the segmental organs of several species of *Limnodrilus*. If they are temporary or constant is difficult to decide upon.

The integument of the body is covered with numerous minute, oblong, and elevated papillæ, which seen by the microscope, present a dark, opaque appearance (Figs. 2*c* and 2*d*). They are absent in the tenth setigerous segment, which contains the efferent duct, &c. The longitudinal axes of the glands are all running in the direction of the width of the body. Somewhat similar papillæ are found in *Enchytræidæ*, but I have observed them nowhere else in this family.

The spines are of six different kinds, viz. hair spines, comb-like spines, and four kinds of forked spines. The hair spines occur in numbers of three to five all along the upper side of the body, and mostly alternating with the comb-like ones, at least in the segments anterior to the cingulum. The prongs of the comb-like or fan-shaped spines are very little separated, and the membrane forming the comb or fan between them very pellucid and often difficult to discern (Figs. 2*l* and 2*m*). The forked spines are of two principal kinds: *a*, spines behind the cingulum, and partly even in front of the same, have the lower prong much broader and longer than the upper one, and the angle between the same nearly a right one (Fig. 2*o*; *b*, the spines in front of the cingulum have the upper prong much longer and even somewhat broader than the lower one. The lower prong is sometimes single, but more often double or even triple (Fig. 2*n**, 2*n*, 2*p*). Similar spines are not found in any other species of the family.

The length of the body, about 15^{mm}, by 1^{mm} wide. The front part of the body is the thickest, and from here it tapers considerably and gradually toward the posterior end. Only the very frontal segments are

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Fig. 2*g* at * shows one of those chambers in optical section.

tapering. The tenth segment is thicker than any other two segments, and forms a well defined-cingulum in adult specimens.

Habitat.—Europe, Sweden: Motala River, in shallow water, together with *Hemitubifex* and *Lumbriculus.* Professor W. Lilljeborg has also kindly communicated specimens taken in Ifö Lake, in Scania; here, however, found at a depth of 25 fathoms.

The specimens from both places were pretty much alike, except in regard to the helix-like swelling of the atrium, which was absent in the specimens from Ifo.

It may be possible that a worm described by Kessler,* under the name of *Nais papillosa*, is identical with our present species. The length of the body and the "*papillæ*" are similar in both species. Kessler's description is, however, so insufficient that nothing can be decided with any degree of certainty, except by autopsy. External characteristics are in no way sufficient to distinguish one species from the other, and have only a relative value as a help in classifying and arranging the specimens in a collection, when it oftentimes is of the highest importance that said work can be done quickly and without destruction or mutilation of the specimens.

Gen. ILYODRILUS *nov. gen.*

The *cephalic ganglion* emarginated both in front and behind.

The *efferent duct* is, compared with the same duct in other genera of the family, short and broad. Its length does never exceed the length of the atrium and penis together. The whole of the atrium is glandular and its lower end is comparatively broad and short. No vesicula seminalis. No glands at the base of the receptacle. No spermatophores. The oviduct is funnel-shaped, the upper end being the widest. The *spines* are of three kinds, viz, hair-spines, comb or fan-like spines, and forked spines. The gap between the prongs of the fan-like spines is comparatively narrow, and the striated membrane between the prongs not always present. In other respects this genus resembles *Tubifex* and *Psammoryctes.* The form of the efferent duct is the most prominent characteristic of the genus.

Only three species are as yet found, and which may easily be classified as follows:

1. True comb-like spines present. The receptacle is bent; oviduct is double; cephalic ganglion about as broad as long.
IL. PERRIERII.
2. Pseudo comb-like spines. The receptacle is bent; oviduct is single; cephalic ganglion is broader than long.
IL. SODALIS.
3. Pseudo comb-like spines. The receptacle is not bent, but globular and inflated; cephalic ganglion about as broad as long; oviduct is single.
IL. FRAGILIS.

* Beiträge zu der Abhandl. der Petersburger Nat.-forsh. Versaml. 1868, pp. 103 to 108. Leuckarts Bericht, 1871.

The pseudo comb-like spines are similar to the comb or fan-shaped ones, but the membrane, between the prongs, is absent. It is evident that the comb-like and pseudo comb-like spines are only modifications, one of the other. To the simply forked spines they are not closely related.

ILYODRILUS PERRIERII *n. sp.*

The cephalic ganglion is about as broad as long, and its anterior end is not broader than the posterior one (Fig. 3*d*).

The efferent duct is shorter than the atrium and penis together, but nearly of the same length as the atrium alone. The penis has no chitinous sheath, is very short and conical, and pointed, gradually tapering towards the apex. The oviduct is double, the interior one being chitinous, extended, funnel-shaped and somewhat bent, gradually tapering towards the exterior porus (Figs. 3*e* and 3*f*). The exterior oviduct is inflated, sack-like, very broad at its base, and from here irregularly tapering towards the exterior apex. It is surrounded by numerous longitudinal muscles, which are connected with the body wall (Fig. 3*e*).

The receptacle is bent, its top being sack-like and not globular (Fig. 3*g*); no spermatophores. The ovaries form two large bodies in the tenth setigerous segment. The testes are comparatively small in the three first segments behind the cingulum, or in the eleventh, twelfth, and thirteenth setigerous segments.

The integument is darker and thicker than in the following species. The membrane between the prongs of the comb-like spines is very pellucid and difficult to perceive. Both prongs are bent in the same direction. The comb-like and hair spines are found all along the upper side of the body (Figs. 3 *h*; 3 *i*; 3 *k*). The integument is flesh-colored.

Length of the body, 10^{mm} to 12^{mm}; width of the same about 1^{mm}. The anterior part is considerably the thickest, and from here the body tapers gradually towards the posterior end (Figs. 3 *a*; 3 *C*; 3 *c*).

Habitat.—Fresno County, California, in irrigation ditches sparingly. In ponds in King's River more frequently met with. I have never found this species much above the level of the prairie, or about 300 feet above the sea.

This species is easily recognized by the thickness of the anterior part of its body.

ILYODRILUS SODALIS *n. sp.*

Nervous system.—The cephalic ganglion is much broader than long, the posterior margin being lined with several (6) ganglionic swellings, of which the two on each side are globular. The two middle ones are oval or conical, constituting the posterior apex of the ganglion (Fig. 5 *C*).

Vascular system.—No differentiated pulsating hearts, only indistinctly or weakly pulsating perigastric vessels, beginning in the ninth setigerous segment and extending towards the cephalic lobe, one pair in every segment; but the nearer the cephalic lobe the smaller are the vessels

and the weaker the pulsations. No dermal vascular system. The gastric secondary vessels are rectilinear. One perigastric and one gastric vessel in every segment. The perigastric vessel is branched, and situated behind the latter near the posterior margin of the segment.

Generative system.—The efferent duct is about one and a half times longer than the atrium and copulative organs together; its width is about the same as in the other species of this genus (Fig. 5 *g*). Atrium is very short and broad, nearly crescent-shaped (Fig. 5 *g*), and the apex of the penis is globular and very much larger than its base. No penis sheath. The oviduct is single, bell or cone like, the lower or exterior end being the widest. The whole organ is full of small spiculæ, somewhat similar to those found in the same organ of *Psammoryctes umbellifer.** The testes are situated in the 10 setigerous segments, beginning in the twelfth and extending to the twenty-second setigerous segment. The ovaries are found in the nineteenth to the twenty-second segment, entirely covered by the testes. The receptacle (Fig. 5 *h*) is somewhat irregular, has two main sack-like lobes, supported on a short narrow stem, at the base of which is found a comparatively large accessory gland (Fig. 5 *h*, gl.).

Numerous perigastric cells of a circular form, and containing numerous globules. The spines are of three kinds, viz, hair spines, forked spines, and pseudo comb like spines, the latter with no membrane between the prongs. The prongs themselves, however, have their inner surface striated (Figs. 5 *e* and 5 *f*).

Similar or nearly similar spines are found in *Ilyodrilus fragilis.* The forked are somewhat similar to the above, but the prongs are not serrated (Fig. 5*c* and 5*d*).

The length of the body is about 25^{mm}; the width of the same about 1^{mm} or more. The integument is reddish-flesh colored.

Habitat.—California, San Francisco, in a spring emptying into the Marine Hospital lake. I have not found the worm in the lake itself.

Ilyodrilus sodalis is a very distinct species, characterized by its cephalic ganglion, receptacle, efferent duct, and pseudo comb-like spines. Its copulative organs are extremely pellucid.

ILYODRILUS FRAGILIS *n. sp.*

(Pl. V; Figs. 4*a* to *g*.)

Nervous system.—The cephalic ganglion is longer than or as long as broad, cordate, with the posterior end considerably narrower than the anterior part (Fig. 4*c*).

Generative system.—The efferent duct is longer than the atrium, but not longer than the atrium and penis together. The atrium is shorter and thicker than in the preceding species; the penis is longer than in

* Vejdovsky, *Zeitsch. f. w. Zoolozie*, Bd. xxvii, page 137.

Il. Perrierii, but of about the same length as in *Il. Sodalis*. The distance between the ventral ganglion and the external generative porus is comparatively great, or about as long as the length of the penis and oviduct together (Fig. 4*d*). The penis is not furnished with any penis sheath (Fig. 4*e*). The oviduct is single, chitinous and somewhat funnel-shaped. Both penis and oviduct are narrowed a little below the middle, but from here they increase in size, and the apex of both are considerably swelled (Fig. 4*e*). Numerous longitudinal muscles are attached with one end to the interior surface of the upper end of the oviduct and with the other to the body wall (Fig. 4*e*, *ms. cl.*). The receptacle is straight, the top inflated, very large, globular, supported by a small narrow stem of less length than half the diameter of the inflated top. The walls of the receptacle are extremely pellucid, much more so than in the preceding species. No spermatophores found.

The integument is more pellucid than in any other species of the genus. The body is of a fine red flesh color, and in size its anterior part not much thicker than its tail.

The spines are of three kinds, viz: hair spines, pseudo comb-like spines, and forked spines (Fig. 4*c*). The prongs of the pseudo comb-like spines are only very slightly serrated.

The length of the body about 15^{mm} (Fig. 4*a*).

The segmental organs are covered with large oblong inflated cells, especially their inner free end (Fig. 4 *g*).

Habitat.—California, Fresno County, Sierra Nevada; in running water in meadows, at an altitude of from 5,000 to 7,000 feet.

Gen. HEMITUBIFEX, *nov. gen.*

(Pls. VII and VIII; Fig. 6.)

Nervous system.—The cephalic ganglion emarginated both in front and behind.

Generative system.—The efferent duct is very long and narrow, as in *Tubifex*. The upper end of the atrium is enlarged, and forms a globular, so-called "vesicula seminalis," upon which the prostate gland is grafted. The lower end of the atrium is glandular. The penis sheath is chitinous, shorter than the oviduct. The oviduct is double-sheathed, both sheaths being chitinous and funnel-shaped, and the outer one surrounded by longitudinal muscles. The base of the receptacle is furnished with accessory glands. The spermatophores are short, thick, and inclosed in a pellucid bag.

The integument is not covered with opaque papillæ. The spines are of two kinds, viz, forked spines and hair-spines. The latter, however, are not always present, as some individuals are found without them. Whenever found they are only sparingly distributed on the upper side of the body. No comb-like spines.

The shape of the atrium, the double oviduct, and the irregularity of the number of the hair-spines are characteristics distinguishing this genus

from any other in the family. The nearest allied one is evidently *Psammoryctes;* but this genus has large and distinctly fan-shaped spines, which are entirely wanting in *Hemitubifex.* As yet only one species known, viz:

HEMITUBIFEX INSIGNIS *n. sp.*

(Pls. VII and VIII; Fig. 6.)

Nervous system.—The cephalic ganglion is nearly square. Its anterior margin is deeply concave; the lobes of the posterior margin are well rounded, and the sinus between them deep and narrow (Fig. 6*g;* Pl. VIII).

Generative system.—The efferent duct is about one-half longer than the atrium and penis together. The atrium is comparatively narrow, except its upper part, which is globular, forming a "vesicula seminalis," upon which the prostata is grafted. This globular part of the atrium is of exactly the same consistency as the lower part of the atrium itself, and differs in this respect from *Psammoryctes*, which genus is said * to have a non-glandular atrium proper. The globular chamber of the atrium can more properly be called a receptacle for the mucus of the prostata gland, when it is mixed with the spermatozoa, descended from the efferent duct. The penis proper is extraordinarily large, thickest a little below its base, and from here gradually tapering towards the exterior apex, which, however, is somewhat swelled and rounded. The penis sheath is chitinous and covers only a part of the penis, leaving the swelled apex and the larger portion of the upper part uncovered. The oviduct is double, both its sheaths being chitinous, funnel-shaped, and about twice as large as the penis sheath (Fig. 6*c*, ovd). Numerous muscles are attached to the interior upper surface of the oviduct and penis proper, binding them to the interior of the body wall. The receptacle is supported by a long, narrow stem, at the base of which are several wing-like glands. The spermatophores are thick and short, generally bent, each one surrounded by a pellucid membrane (Fig. 6*h*).

The segmental organs are long and narrow. The interior aperture is surrounded by two nearly equal lobes; no inflated cells and no enlarged chambers, as in *Spirosperma.*

The integument is very smooth, and the body of the worm resembles much that of *Limnodrilus* or *Tubifex.* The spines are of two kinds, hair-spines and forked spines. The latter are regularly dispersed two and two in each fascicle, except on the upper or dorsal side of the body, where we occasionally also find a few hair-spines. The distribution of these is very irregular. In one specimen they were found in the third, fourth, seventh, twelfth, and thirteenth segments, but even here not in all the upper fascicles. In another specimen from the same locality I

* Vejdovsky, *Zeitsch. f. w. Zoolozie;* Bd. XXVII, page 138.

found no hair-spines at all. Of the forked spines the lower prong is much wider and longer than the upper one, and the angle between the prongs is nearly a right one (Fig. 6 C.).

The length of the worm is about 30^{mm}, and the width less than 1^{mm}. The cingulum is small and hardly perceptible.

Habitat.—Sweden, Europe, Motala River, in shallow water near the shore.

Gen. PSAMMORYCTES *Vejdovsky*, 1877.

SYN. 1868. *Sænuris*, Kessler, Beitrage zud. Obhandbung. d. Petersburger Nat. Forsch. Versaml., p. 108.
1871. *Tubifex*, E. Ray Lankaster, Annals & Mag. of Nat. Hist., vol. vii, 1871, pp. 90, 101.
1875. *Tubifex*, Ed. Perrier, Syr. l. Tubifex etc. Arch. Zool. exper. et gen. tom. iv, No. 1. Notes et Revue, p. 6, 1875.
1877. *Psammoryctes*, Vejdovsky, Zeitschr. f. wiss. Zoologie; Bd. xxvii p. 137.

From the descriptions of the above authors the following seem to be the main characteristics of the genus: The atrium is furnished with a large globularc hamber called vesicula seminalis, upon which the prostate gland is "grafted." That part of the atrium which is situated between this chamber and the penis proper is *not glandular*, but translucid, narrow, and sometimes furnished with small circular chambers.

The comb-like spines are fan-shaped, the membrane between the prongs being very plainly visible.

For further particulars about this genus I beg to refer to the above cited authors.

Only one species as yet known, viz:

PSAMMORYCTES UMBELLIFER (*Kessler*, 1868).

SYN. 1868. *Sænuris umbellifera*, Kessler l. c., p. 108.
1877. *Psammoryctes umbellifera* Vejdovsky l. c., p. 137.

Species characteristics the same as for the genus. The spines are of three kinds, viz, hair-spines, comb-like spines, and common forked spines. Of the latter we find two varieties.

Habitat.—Europe, Russia, Bohemia, England, &c., in fresh or brackish water, as it seems very widely distributed.

Further ahead, when speaking of the general organization of the oviducts and penis sheath, I will return to this species and give some reasons why I think that said organs have been in this as well as in some other species erroneously observed or misunderstood.

Gen. TUBIFEX *Lamark*, 1818.

Nervous system.—The cephalic ganglion emarginated both in front and behind.

Generative system.—The lower end of the atrium is comparatively broad; not so broad, however, as in Ilyodrilus. Both oviduct and penis sheaths present. The oviduct is wide and short.

Integument furnished with only two kinds of spines, viz, hair-spines and forked spines. Fan-shaped or pseudo comb-like spines never present.

As can be seen, the above characteristics are neither very pointed nor at all sufficient to fully characterize the genus, but the descriptions of the different species belonging to this genus are mostly so inadequate that no better genus-characteristics could at present be compiled. Of the four species known I have seen only one, viz, *Tub. campanulatus*. *Tub. Bonneti* is sufficiently described by *Claparide*, and seems easily distinguished from any other. Of the remaining two species, I have seen neither specimens nor descriptions, and must, in regard to them, trust to the authority of the respective authors.

TUBIFEX RIVULORUM Udekem, 1853.

SYN.: *Tubifex rivulorum.*

D'Udekem, J. Hist. Nat. d. Tub. riv. Mem. Cour. par. l'Acad. d. Belgigue, Tom. XXVI, 1855.

TUBIFEX COCCINEUS Vejdovsky, 1875.

SYN.: *Tubifex coccineus* Vejdovsky.

Sitzungsb. Mathend, Nat. vissensch. Classe d. Böhm, Gesellsch Wessenschaft, Oct. 29, 1875, p. 3.

This and the following species, *Tub. Bonneti*, are said to have the receptacle in the tenth, and the sexual pore in the eleventh segment.

Tub. rivulorum and *Tub. campanulatus*, on the contrary, have the same organ in the respective segments, 9 and 10, or in one segment nearer to the cephalic lobe. I can hardly account for this seeming difference in any other way than that the respective investigators have counted the segments in different ways. It is natural that when every investigator has not only had his own way of counting the segments, but also changed that way at different times, that much confusion will ensue. For our purpose it is materially indifferent if we count the cephalic lobe as a segment *per se*, or if we, as the first segment of the body, assign the first setigerous one, if we only can agree to one or the other. Myself and d'Udekem count the first setigerous segment as the first segment of the body, and accordingly we find the receptacle to be situated in the ninth and the sexual porus in the tenth segment. Claparède and Vejdovsky, on the contrary, consider the first setigerous segment to be the second segment of the body, which, of course, places the sexual porus in the eleventh segment.

I have, to prevent further complications, and in order to immensely simplify the counting of the segments, here adopted the plan to name the segments surrounding the oral orifice, respectively the *cephalic lobe* and the *buccalic segment;* and, further, to assign the name of the first segment only to the first setigerous one. And, to avoid any possible misunderstanding, it would, when speaking of the segments, be well to add "setigerous."

TUBIFEX BONNETI *Clap.* 1868.

SYN.: *Tubifex Bonneti.* Claparède, Recherches Anatomiques, etc., p. 13.

The most characteristic feature of this species is the vase-like form of the oviduct, which latter is of about the same length as the penis.

Habitat.—Europe; Switzerland.

TUBIFEX CAMPANULATUS *n. sp.*

[Pt. VIII, Fig. 7.]

Nervous system.—The cephalic ganglion is longer than broad, and in front considerably broader than behind, where the emargination is deep and narrow (Fig. 7*a*).

Generative system.—The penis is broadest at the middle, and from there tapering toward both ends. The penis sheath is of the same form as the penis, only broader and longer (Fig. 7*c*). The oviduct is bell-shaped, the widest end being turned towards the exterior penis. The length of the oviduct is only half that of the penis, but its width at its lower end is nearly three times that of the penis (Fig. 7*c*). The exterior oviduct is membrane-likè, and surrounded by two large trunks of longitudinal muscles, which connect the oviduct with the body wall. This exterior oviduct is twice as long as the interior one (Fig. 7*c*). The receptacle is bent in the shape of an S, with the upper end enlarged and sack-like (Fig. 7*d*).

Spines.—The two prongs of the forked spines are of nearly the same size, and the angle between them is less than a right angle.

Length of the body about 15^{mm}.

Habitat.—Europe, Sweden, Christianstad.

Tubifex profundicola Verrill (American Journal of Science, 3d series, vol. ii, p. 450, 1871) is evidently no *tubifex* at all, if the spines are correctly described. Those of the ventral fascicles are said to be longer than those of the dorsal ones. All the setæ are hooked or forked—characteristics which place the worm in or near the genus *Limnodrilus*.

Gen. LIMNODRILUS *Claparède*, 1862.

SYN.: *Limnodrilus* Claparède l. c., p. 25, 1862.

Nervous system.—The cephalic ganglion emarginated both in front and behind.

Generative system.—The lower end of the atrium is generally long and narrow, and comparatively narrower than the corresponding parts of *Tubifex* and *Ilyodrilus*.

The copulative organs are not surrounded by spiral muscles; generally by longitudinal, seldom by circular ones.

Integument.—Only one kind of spines, viz. forked spines.

The principal characteristic of this genus is evidently the total absence of hair spines and fan-shaped spines. In other respects this genus seems to resemble *Tubifex*. It is, however, likely that when a larger

number of species has been studied new and more distinct characteristics may be discovered. A prominent feature of the genus is also the elongation and narrowness of the copulative organs. In all other genera except *Camptodrilus* said organs are much shorter, especially so the oviduct. In *Tubifex* we find the shortest and widest oviducts; in *Limnodrilus* and *Camptodrilus* the longest and narrowest.

In the following synoptic table the three species, *L. Hoffmeisteri* Clap., *L. Udekemianus* Clap., and *L. Claparèdianus* Ratzel, are not classified. I have not had opportunity to see those species myself, and as some points in the description of their reproductive organs, &c., are wanting, it has as yet been impossible to arrange them systematically among the other species. They seem, however, to be nearest related to *L. monticola* and *alpestris:*

A. The oviduct is single. The upper end of the penis sheath furnished with a crown of star-like concretions.

LIMNODRILUS ORNATUS.

B The oviduct is double. The upper end of the penis sheath not furnished with star-like concretions.

1. The penis proper projecting outside the penis sheath and here forming a globular head. Inner oviduct muscular.

LIMNODRILUS STEIGERWALDII.

2. The penis proper not projecting outside the penis sheath, and its lower end not forming a globular head. The inner oviduct is not muscular, but chitinous.

a. The lower end of the penis proper is truncate and somewhat wider. The lower end of the interior oviduct is wider than its middle.

LIMNODRILUS MONTICOLA.

C. The lower end of the penis sheath is pointed. The lower end of the interior oviduct is wider than its middle.

LIMNODRILUS ALPESTRIS.

c. The lower end of the penis proper is pointed or rounded. The lower end of the oviduct is much narrower than its middle or upper part.

LIMNODRILUS SILVANI.

LIMNODRILUS ORNATUS *n. sp.*

(Pl. IX; Fig. 8.)

Nervous system.—The cephalic ganglion is broadest posteriorly, the two lobes being well rounded and separated, but the sinus between them is rather shallow (Fig. 8*c*).

Generative system.—The penis is long and slender, broadest at its upper end, and from here gradually tapering towards the apex, which, however, is not tapering, but cylindrical. The penis sheath is long, cylindrical, trumpet-shaped at both ends, and slightly narrowest at the middle. Its upper end, at the entrance to the oviduct, is furnished with a crown of star-like concretions, of a brown, chitinous consistence (Fig. 8*d* crn.) The oviduct is single, sack-like, and longer than the penis sheath. In the same no cellnuclei are visible. Surrounded by longitudinal muscles. The receptacle is elongated, and of a flask-like shape,

sometimes constricted at the middle (Figs. 8*e*; 8*f*). No spermatophores are found.

The segmental organs are long and very narrow; not surrounded by bladder-like cells (Fig. 8*h*).

Integument is hard and tough. The spines are short, and their exterior end not much curved. The opening between the prongs is narrow, and the upper prong is longer than the lower one.

Length of the body, about 30^{mm}; width of the same, about 1^{mm} or less.

Habitat.—California, San Joaquin River, in a pond, found attached to decaying wood floating on or immersed in the water.

The principal characteristics of the species are the star-like concretions round the upper end of the penis sheath. The brown color of the concretion fades when the animal has been preserved in glycerine. The generative organs are comparatively minute, or of about half the size of those of *L. alpestris.*

LIMNODRILUS STEIGERWALDII *n. sp.*

(Pl. X; Fig. 9.)

Nervous system.—The anterior part of the cephalic ganglion is the widest, and emitting several large ganglionic lobes toward the cephalic lobe of the body. The posterior margin is abruptly emarginated, and the whole posterior part of the ganglion is nearly globular (Fig. 9*c*).

Generative system.—The generative organs are, in proportion to the great length of the body, comparatively short. The lower end of the penis is globular, the globular part being situated outside of the penis sheath, within which it cannot be retracted. The penis sheath is chitinous, about eight times as long as wide. Its form is cylindrical, with trumpet-shaped ends, the lower one being the widest (Fig. 9*c*, ps.). The oviduct is muscular, thickest at the middle, round the globular swelling of the penis, from here gradually tapering toward the exterior orifice. The exterior orifice is sack-like, much wider and with thinner walls than the interior one. In its walls the cell nuclei are all plainly visible. The atrium is unusually small, and the lobes of the prostate gland minute and globular. The ovaries are much bent, tapering toward the extremities. The ripe ova are found on the middle of the ovary (Fig. 9*f*). The receptacle is nearly straight, broadest at its inner apex.

Segmental organs are not furnished with globular cells, except their inner orifice, which is surrounded by globular swellings, increasing in size toward the orifice itself (Fig. 9*e*). The orifice is surrounded by two lips, the upper one of which is furnished with a long vibrating epithelium (Fig. 9*e*).

The length of the body in large specimens 30^{mm}; width of the same from 0.75 to 1^{mm}. The body tapers gradually toward the posterior end.

Habitat.—Sierra Nevada, California, in the bottom of running springs. in meadows, at an altitude of 7,000 feet.

The principal characteristic of the species is the enlargement of the lower end of the penis.

LIMNODRILUS MONTICOLA *n. sp.*

(Pl. XI, Fig. 10.)

Nervous system.—The cephalic ganglion is nearly square, the posterior lobes well rounded but not much projecting (Fig. 10*c*).

Generative system.—The generic organs are comparatively minute. The lobes of the prostata are not globular and not much elevated, the whole gland being larger and more compact than in the preceding species. The penis is nearly cylindrical, and only slightly widening toward the exterior truncate end. The penis sheath is also cylindrical, slightly widening toward both extremities. Its exterior end is not deflected, sometimes rather the contrary. The penis and penis sheath are of the same length. The oviduct is double. The interior one is chitinous and resembles closely the penis sheath, being only wider but not much longer. Its lower extremity is sometimes deflected and plate-like, especially in very matured specimens (Figs. 10*e* and 10*f*).

The exterior oviduct is, as usually, sack-like. Its upper part covers the interior oviduct closely; its lower end is wider, with plainly visible cell nuclei. The receptacle is straight, sometimes constricted at the middle, generally found containing spermatophores of usual shape (Figs. 10*g* and 10*h*).

The spines are very slender, curved, the upper prong of the fork slightly the longest (Fig. 10*c*).

The length of the body 30^{mm}.; width of the same 0.75^{mm} (Fig. 10*a*).

Habitat.—California, Sierra Nevada, at Seven Spring Meadow, on the east side of the North Fork of King's River. Numerous specimens found in or between decaying wood submerged in the water. Altitude about 9,000 feet.

The principal characteristic of the species is the cylindrical form of the penis and its truncate end. The other species of the genus have the extremity of the penis either globular or pointed, or present other forms easily recognizable.

LIMNODRILUS ALPESTRIS *n. sp.*

(Pl. XII, Fig. 11; Pl. XVII, Fig. 11; Pl. XVIII, Fig. 18.)

Nervous system.—The posterior part of the cephalic ganglion is the broadest, sometimes furnished with three well-rounded lobes. The swellings of the ventral ganglion are almost circular. In not fully developed specimens the cephalic ganglion is two-lobed (Fig. 91*a*).

Generic system.—Of the generic organs, the penis and the oviduct are comparatively longer than in any other species of the genus. The lower extremity of the penis is slightly swelled and pointed. The penis sheath is trumpet-shaped at both extremities, the exterior one being the widest.

The interior oviduct is of nearly exactly the same form and size as the penis sheath; if anything a little shorter. The exterior oviduct does also inclose the penis sheath and interior oviduct securely, and is only sack-like at its lower end, which is rather muscular and unusually short (fig. 11C). The atrium is of somewhat variable form, its upper part sometimes being rather unusually swelled (fig. 11, Cx). More generally the atrium tapers toward both extremities. The receptacle is enlarged at both extremities, the upper one being bent and helix-like (Fig. 11*d*). The testes are found in the tenth to fourteenth or fifteenth setigerous segments. The spermatophores are numerous, and of variable form (Fig. 11*efg*).

The segmental organs are comparatively short, surrounded by a heavy mass of granulated matter, but not by any globular cells (Fig. 11*h*).

The length of the body about 25^{mm} by 0.75^{mm} wide. The integument is very tender, causing the worm to easily break.

Habitat.—California, Sierra Nevada, in the mud of running springs, at an altitude of 7,000 feet.

The principal characteristic of the species is the length and form of the penis sheath and oviducts, also the form of the cephalic ganglion.

LIMNODRILUS SILVANI *n. sp.*

(Pl. XIII, Fig. 12; Pl. XIV, Fig. 12.)

Nervous system.—The form of the cephalic ganglion is variable. In large specimens the ganglion is much wider than long, and sometimes furnished with three posterior lobes; in smaller specimens the ganglion is much longer than broad and never three-lobed (Figs. 12*e* and 12*f*). Between these two forms intermediate ones are found but rarely.

Generative system.—The lower end of the penis proper is rounded and somewhat swelled. The penis is only half as long as its chitinous sheath and only slightly thicker than the lower end of the atrium (Figs. 12*p* and 12*q*).

The penis sheath is seen from the side gradually tapering towards the exterior apex, with the exception of an abrupt enlargement at the middle, just at the end of the penis proper. Seen from the front, however, it presents a very different appearance. It then nearest resembles an arrow-head or trowel (Fig. 12*q*, p. s.).

The oviduct is double. The interior one is about three-fourths as long as the penis sheath. Seen from the side, it resembles an arrow quiver. Seen from the front, its lower end is found to closely inclose the lower, or an arrow-head resembling part of the penis sheath, but its upper third is wider than the upper half of the penis sheath. The exterior oviduct is more sack-like, and somewhat loosely incloses the interior generic organs. The efferent duct is extremely long; the prostate is very irregular, but rather compact.

The receptacle consists of three parts, viz: One middle part, which

is narrow, and the two extremities, which are swelled and sack-like, especially the upper one. The latter and the middle part are bent over and cover the lower part sometimes entirely. In the long form of the worm the receptacle was found always more or less straight (Fig. 12*q*).

The spermatophores are numerous and of various forms. The ovaries are long and comparatively very narrow, developing the ripe ova at their middle (Fig. 12*r*).

The segmental organs are long and narrow (Figs. 12*n* and 12*o*); not surrounded by globular cells.

The integument is very tough. The spines are slightly curved; the angle between the two prongs is in the anterior spines nearly a right angle, but in the posterior spines of much smaller aperture. (Fig. 12, *c. d.*)

Of this species exist two different sized forms. One is about 18^{cm} long and 2^{mm} broad. The other is only 5^{cm} long by $1\frac{1}{2}^{mm}$ to 1^{mm} broad. Both forms are found fully matured, and both differ somewhat anatomically from each other. Intermediate forms are found, but not very numerous. In one of two neighboring ponds both forms are found, and intermediate ones between them. In the other pond or lake I have as yet found only the smaller form, and no intermediate ones (Fig. 12*a* and *b*).

Habitat.—California, San Francisco. In Laguna del Mercedes only the smaller form. In Mountain Lake or "Marine Hospital Pond" both forms are found. In "Laguna del Tache" only the smaller forms.

The following species are sufficiently well described to be recognized, but not sufficiently enough to enable me to arrange them systematically in the genus. For their characteristics I must refer to their respective describers.

LIMNODRILUS UDEKEMIANUS *Clap.*

SYN.: *L. Udekemianus* Claparède, Recherches anatomiques sur les Oligochætes, prz. 27, Geneva, 1862.

LIMNODRILUS HOFFMEISTERI *Clap.*

SYN.: *L. Hoffmeisteri* Claparède, *l. c.*, prz. 32.

LIMNODRILUS CLAPARÈDIANUS *Ratzel.*

SYN.: *L. Claparèdianus* Ratzel, Z. f. wissenschaftl. Zoologie, Bd. xviii, s. 563 to 591.

All of the above three species are found in Europe.

Gen. CAMPTODRILUS *nov. gen.*

Nervous system.—The *cephalic ganglion* is both anteriorly and posteriorly emarginated, and in this respect resembling all other genera except *Spirosperma*.

Generative system.—The copulative organs are much elongated, and partly surrounded by spiral muscles, one end of which is attached to

the exterior oviduct, the other to the interior surface of the body wall, near to the genital porus. In other respects this genus resembles *Limnodrilus*. Generally it may be said that the copulative organs of this genus are comparatively longer and narrower than those of any other genus of the family.

The spines are only of one kind, viz, forked spines.

Camptodrilus is well distinct from all other genera; from most of them by having only forked spines, and from all of them, especially from its nearest allied *Limnodrilus*, in having spiral muscles wound round the copulative organs.

Only four species as yet known.

A. The oviduct is double; the interior one chitinous; the lower end of the penis sheath suddenly increasing in size, deflected and plate-like.

C. SPIRALIS.

B. The oviduct is single, not chitinous.

a. The anterior margin of the cephalic ganglion is broader than the posterior one. The exterior end of the penis sheath is suddenly expanded and plate-like.

C. IGNEUS.

b. The cephalic ganglion is nearly square, broader behind than in front. The exterior end of the penis sheath is very gradually increasing in width, and not suddenly expanded nor plate-like.

C. CORALLINUS.

c. The posterior margin of the cephalic ganglion is the broadest, and well rounded. The exterior end of the penis sheath is suddenly increased in width, funnel-shaped, but not plate-like.

C. CALIFORNICUS.

CAMPTODRILUS SPIRALIS *n. sp.*

(Pl. XVII, Fig. 15.)

Generative system.—The spiral muscles surrounding the copulative organs are finer than those of any other species known, and may sometimes be easily overlooked. The penis sheath is long and narrow, and nearly perfectly straight. Its exterior end is suddenly increasing in size, deflected, but not plate-like (Fig. 15, *a*). The oviduct is double. The interior one is of the same shape and general size as the penis sheath, only wider in both extremities. The exterior oviduct is sack-like at its lower end, and somewhat resembling the same organ of *Camptodrilus igneus*. The receptacle is long, sack-like, and bent at the middle.

The segmental organs are not furnished with globular cells, and their interior apertures are not surrounded by glandular agglomerations (Fig. 15, *d*).

The spines are slightly curved, and the angle of the prongs is larger in spines from the posterior segments than in those from the anterior ones (Figs. 15 *b* and *c*).

The body is about 25^{mm} long by 1^{mm} wide, and of a steel-blue color. When touched the animal coils itself into a spiral, and accordingly alcoholic specimens are never found extended. The integument is tender.

Habitat.—California, Sierra Nevada, Fresno County, at an altitude of 7,000 feet, in stagnant water in the meadows; never in the very stream.

CAMPTODRILUS IGNEUS *n. sp.*

(Pl. XIV, Fig. 13.)

Nervous system.—The cephalic ganglion is broadest in front; its posterior margin is deeply emarginated, on both sides surrounded by very pointed lobes. The frontal lobes are each covered with several globular swellings (Fig. 13, *b*).

Generative system.—The penis sheath is long and extremely narrow, its lower or exterior end is suddenly expanded, deflected, and rather plate-like. From behind this deflection the penis sheath gradually increases in thickness towards the upper or inner end of the sheath (Fig. 13 *c* and 13 *g*, Pl. XVIII). The oviduct is single sack-like, of a very elongated form. The lower end of the oviduct is very much the widest, and in the same the cell nuclei are plainly visible. The spiral muscles surrounding the copulative organs are very strong and distinct, unlike those of the preceding species, *C. spiralis.* The receptacle is bent and sack-like, not found containing any spermatophores (Fig. 13, *d*).

The segmental organs are in all the segments furnished with a coating of perfectly globular cells, with plain cellnuclei situated close to the tube of the organ (Fig. 13, *e*).

The perigastric cavity contains free and floating perigastric cells of somewhat variable form (Fig. 13, *f*).

The integument of the body is extremely tender. Color fiery red, under the microscope yellowish. Size of the body about 30^{mm} by 0.75^{mm} wide.

Habitat.—California, San Francisco, Oakland, Santa Clara Valley and neighborhood. Adult in March.

This species is especially remarkable for its fiery color, which gives to the borders of the ponds wherever it is found a very vivid appearance. The shape of the cephalic ganglion and the plate-like extremity of the penis sheath are distinct characteristics of the species.

CAMPTODRILUS CORALLINUS, *n. sp.*

(Pl. XVI, Fig. 14; Pl. XVII, Fig. 14; Pl. XVIII, Fig. 14.)

Nervous system.—The cephalic ganglion is nearly square, and its posterior emargination rectangular, or nearly so (Fig. 14 *d*).

Generative system.—The penis sheath is gradually increasing in width towards its exterior extremity, which is considerably bent, not much deflected nor plate-like. Figs. 14 *e* and 14 *l* represent the reproductive organs as generally found. Figs. 14 *i* and 14 *k* represent the lower end of the penis sheath, with a small deflection of its margin, as it sometimes is found. The oviduct incloses the penis sheath tightly, except

at its lower end, which is sack-like and extending beyond the same. The cell nuclei in the same are not plainly visible. The ovaries are short, bent in a right angle, in which latter the ova are developed (Fig. 14 *g*). The receptacle is short, wide, and sack-like, and the stem which supports it is much smaller than in any other species.

The segmental organs in front of the cingulum are all furnished with globular cells, but those in the segments behind the same have no globular cells. No glandular agglomerations round the interior aperture of the organ.

The color of the body is yellowish red, with a light or not colored band between every segment, giving the worm somewhat the appearance of a string of red corals. The last posterior segment is five or six times longer than the segment preceding the same. The length of the body is variable, the general size being from 25^{mm} to 30^{mm}, but sometimes it reaches from 60^{mm} to 70^{mm}, with a width of from 1^{mm} to 1½^{mm}. The in, tegument is tough, giving some tenacity to the body.

Habitat.—California, Fresno County, in ponds, or even in the running waters of King's River, Dry Creek, &c., always near the level of the prairie.

CAMPTODRILUS CALIFORNICUS, *n. sp.*

(Pl. XVIII, Fig. 16.)

Nervous system.—The cephalic ganglion is nearly square, posteriorly well rounded, with a shallow emargination.

Generative system.—The copulative organs are all strongly built, and the spiral muscles heavier than in any other species of the genus. The penis sheath is at its lower end suddenly increased in size, deflected, but not plate-like. The oviduct is single, surrounds the penis sheath tightly; its lower end is, however, more sack-like, resembling in this respect the corresponding part of *C. corallinus.*

The segmental organs are not furnished with globular cells.

The body is of about the size, color, and tenacity as that of *C. igneus.* The tail is distinctly segmented, and the last segment not longer than the preceding one.

Habitat.—California, San Francisco, Oakland, Lagunitas, Russian River, &c., in ponds or stagnant water, only seldom in the streams themselves.

As the species of this genus are somewhat difficult to distinguish the one from the other, the following comparison of their principal characteristics may prove useful.

C. spiralis has a double oviduct. Its penis sheath resembles that of *C. igneus*, but is comparatively shorter. The copulative organs have also some resemblance with those of *L. alpestris*, but this species has no spiral muscles.

C. igneus has a single oviduct, and is further distinguished by the plate-like deflection or enlargement of the lower end of the penis sheath, above which it is suddenly decreased in size.

C. corallinus has also single oviduct, but the penis sheath is gradually increasing in size from the middle toward its lower or exterior end. This species is somewhat larger than any other in the genus, and the integument of its body tougher.

C. californicus has the exterior end of the penis sheath suddenly expanding and deflected, but the deflection is not plate-like, only trumpet-shaped. The whole organ is also comparatively shorter and thicker than in *C. igneus*. The oviduct is single. The copulative organs of this genus are comparatively longer and narrower than those of any other genus, *Limnodrilus* excepted.

B.—GEOGRAPHICAL DISTRIBUTION.

Our present knowledge of the distribution of the genera and species of *Tubificidæ* is so very limited that any general comparison between the countries and the species inhabiting the same can hardly be expected. *Tubificides* are as yet known only from Europe and North America, but there is every reason to believe that we will find them distributed all over the globe wherever ponds, streams, lakes, or wells can be or are found. I have as yet not seen any permanent water, and hardly any larger temporary ones, where *Tubificidæ* could not be collected.

The above list of species must by no means be considered as in any way exhaustive; on the contrary, the few species known can only constitute a small portion of what in reality exists, and I feel fully satisfied that hundreds, if not thousands, of species will be found, when the different waters of the continents and islands are thoroughly searched.

Here, then, will we find a class of animals, as yet hardly investigated and very insufficiently known, which in the near future may furnish a rich supply for the student of natural history.

The study of the geographical distribution of the species of *Oligochæta* must also be in the highest degree an interesting one, even more so than the geographical distribution of most other classes of animals, such as birds, reptiles, and mammalia. While the latter have numerous ways of transportation on land, through air and water, the slowly moving *Oligochætes* are mostly confined to the very element in which they live, and outside of which they and their eggs would soon perish. The fauna of terrestrial animals, with their various means of locomotion, may have changed many times, while the *Oligochætes* in the earth, relatively secure from enemies and less subject to climatic changes, may have survived for ages. Thus the study of the distribution of the *Oligochæta*, especially the purely terrestrial ones, may not only be of value in considering the former connection of continents and islands, but also in the study of the climatic changes they have undergone. So have I, for instance, been led to believe with a reasonable degree of cer-

tainty that the climate of California, dry as it is, is gradually changing to a damp one, and that for the following reasons:

If Middle and Southern California in former, not to say distant, ages had enjoyed a moist and rainy climate, its soil in favorable places would most likely contain numerous earth-worms. I naturally judge this from analogy, as there is no country which is not absolutely dry for any length of time where earth-worms are wanting. If now, therefore, the climate of California began to get drier, the worms formerly distributed over the whole of the country would naturally recede to the remaining moist land around the water-courses, and, finding here the necessary conditions for existence, remain to the present day.

But in Middle and Southern California I have hunted in vain for native *Lumbricides*, and even so in the always moist earth around King's and San Joaquin Rivers, places at present climatically isolated. From these facts I draw the conclusion that even in former time no climatical connection existed between the said river valleys and other countries inhabited by earth-worms and that the climate, if changing at all, is getting moister, being formerly an arid one.

Around San Francisco and other cultivated places throughout California we find in the gardens several imported European species of earth-worms and only one single species which at present is known only from California.

If similar conclusions can be drawn from the study of *Lumbriculidæ* or terrestrial *Oligochæta*, it may also be reasonable to suppose that even the geographical distribution of the Limicolide worms will enlighten us upon subjects related to a country's former geographical and climatological connections.

It is, of course, as yet too early to speculate further upon these points, or to draw any conclusions from the few with certainty known facts, but I have here only wished to call attention to the importance of the geographical distribution of this class of animals, and, which of course is partly the same, to the study of their different species.

While many classes of animals exhibit both more attractive features, more gorgeous colors, and are more easily studied, they therefore in no way are any more valuable to the science of natural history, and it would even be well if scientific expeditions and private collectors would more generally and with more generosity divide their attention between the popular and not popular classes of the animal kingdom.

But, returning to the geographical distribution of the species, we find that about 22 species of *Tubificidæ* are as yet known, and about equally divided between Europe and North America, provided we only consider species which are sufficiently well described to be recognized and classified.

Among species as yet insufficiently known I consider *Sænuris abyssicola*, *Sænuris limicola*, *Tubifex profundicola*, *Chirodrillus larvæformis*,

and *Chirodrillus abyssorum*, all of which are American species.* It is even very doubtful if *Chirodrillus* can be considered a *Tubificidæ*, it having six fan-shaped fascicles of setæ on each segment.

The species from Russia, described by *Kessler*, *Nais papillosa*, *Nais gigantea*, *Sænuris longicauda*, may all be what we call good species, but as yet we know too little of them to enable us to properly classify them. Of a supposed identity of *Nais papillosa* and *Spirosperma* I have spoken under the heading of the latter species.

Besides the above species, we know from Europe the following 10, viz: *Spirosperma*, 1 species; *Hemitubifex*, 1 species; *Tubifex*, 4 species; *Limnodrilus*, 3 species; and *Psammoryctes*, 1 species.

The rest of the species are all from California. From the eastern part of America I have not seen any species of *Tubificidæ*, but have the authority of several zoologists for their numerous occurrence.

The following table will better show the distribution of the species:

	Sweden.	Russia.	Bohemia.	Switzerland.	Germany.	France.	Belgium.	England.	California.
Telmatodrilus Vejdovskyi									*
Spirosperma ferox	*								
Hemitubifex insignis	*								
Ilyodrilus Perrierii									*
sodalis									*
fragilis									*
Psammoryctes umbellifer		*	*			*		*	
Tubifex rivulorum							*		
coccineus			*						
campanulatus	*								
Bonneti			*	*					
Limnodrilus Hoffmeisteri			*	*					
Udekemianus			*	*					
Claparedianus					*				
ornatus									*
Steigerwaldii									*
monticola									*
Silvani									*
alpestris									*
Camptodrilus spiralis									*
igneus									*
californicus									*
corallinus									*
	3	1	5	3	1	1	1	1	13

C.—SPINES.

The most prominent external characteristics of the species of this family are derived from the spines. We can of them distinguish five different kinds or varieties, viz:

1. Entire spines.
2. Forked spines.
3. Hair spines.
4. Fan-shaped or comb-like spines.
5. Pseudo-comb-like spines.

* *Verrill*, in extract from report of S. F. Baird, Commissioner of Fisheries, Part II, Rep. for 1872–'73, pp. 697–699.

The entire spines resemble those of *Enchytræidæ*. They are found only in *Telmatodrilus*, and occur here in fascicles, of which four are found in every segment. In each fascicle we find nine or more spines, all of nearly equal length. In very young individuals the exterior end of these spines show a tendency to forking, which, however, entirely vanishes by advanced age.

Nearest related to these spines are the forked spines. They resemble the former, except in regards to their exterior apex, which is forked. Such spines occur in all the species of *Tubificini*. The angle of the fork and the length and form of the prongs are important characteristics of the species. The fork of the spines is oftentimes different in different segments of the same species. Such is the case in *Psammoryctes** and in *Spirosperma* (Fig. 20; 2 *n*.)

Generally the prongs of the spine are only two, but in *Spirosperma* we find three or sometimes even four (Figs. 2 *n*, 2 *o*, and 2 *p*). Such spines, however, are only found in the interior segments of the body.

The forked spines are generally found in fascicles by themselves, but sometimes also, as in *Tubifex* and *Hemitubifex*, alternating with hair spines in the same fascicle on the upper side of the body. Forked spines and fan-shaped spines are never found mixed or alternating in the same fascicle. In *Limnodrilus* and *Camptodrilus* we find only forked spines, but in all the other genera we find at least two kinds of spines, viz, forked and hair spines.

The hair spines are characterized by their length, oftentimes exceeding the width of the body of the worm. They are only found on the upper side of the body, and generally only in the anterior segments. In *Tubifex* and *Hemitubifex* they are found alternating with common forked spines, but in *Ilyodrilus*, *Spirosperma*, and *Psammoryctes* with fan-shaped or pseudo-comb-like spines. The general number of spines in such a fascicle is from five to six of each kind, varying, however, in the different segments.

The fan-shaped or comb-like spines are peculiar to the genera *Psammoryctes*, *Spirosperma*, and *Ilyodrilus*. They are characterized by having a finely striated membrane stretched between the prongs of a forked spine. There is, however, a difference between the prongs of a purely forked spine and a comb-like one. Those of the former are always more curved than the latter, which sometimes even are both bent either inward, as in *Psammoryctus*, or outward, as in *Spirosperma*. The comb-like spines are only found in the upper side of the segments, and always alternating with hair-spines.

As pseudo comb-like spines, I have designated spines the prongs of which resembled those of the former class, but which were not connected by any membrane whatever. The inner side of the prongs presented a strongly striated surface, evidently the first beginning of a distinct striated membrane. Such spines I have found only in the genus *Ilyodrilus* (Figs. 5 *e*, 5 *f*).

* Vejdovsky, Ueber *Psammoryctes*, page 140.

D.—VASCULAR SYSTEM.

The vascular system of *Tubificidæ* takes an intermediate place between those of *Enchytræidæ* and *Lumbriculidæ.* It is more complicated than in the former family, but less so than in the latter.

The main truncs are found to be a ventral vessel and a dorsal one. The former is forked in the fourth setigerous segment, the latter continues entire to the cephalic lobe of the body. Only the dorsal vessel is pulsating. Besides the above primary vessels we find three other kinds, viz, gastric, perigastric, and dermal.

The gastric vessels, again, are of two kinds, viz, secondary and tertiary. The secondary gastric vessels are in every segment two, and situated near the anterior dissipiment of the segment, one on each side of the body. They are found to closely embrace the gastric canal, hence their name, and serve to directly connect the ventral and dorsal vascular truncs.

From these secondary and gastric vessels we find numerous others, very minute ones, spreading and branching on the alimentary canal; they serve eminently to carry the blood to this organ, and are most likely present in all the species of the family.

Of the perigastric vessels we also find one pair in every segment, but situated behind the gastric pair. In the same way as this latter it connects the ventral and dorsal vessels with each other, but is narrower, longer, and its windings are more irregular. As their name implies, their chief function is to supply the perigastric cavity with blood, and partly, also, the sexual organs suspended in the same cavity. Thus we find always the perigastric vessels much larger and longer in those segments which contain receptacles and testes, &c., and their windings are oftentimes inseparably united with the latter organs. Such is especially the case in *Telmatodrilus* and *Ilyodrilus.*

The perigastric vessel in the seventh setigerous segment is generally considerably dilated, shows a strongly pulsating movement, and takes evidently the function of a heart. Of such hearts I have never found more than one pair in each worm.

In *Telmatodrilus* and *Ilyodrilus*, however, the perigastric vessels are not dilated, and no distinct hearts can be said to be existent in those worms. A substitute is, however, found in the great extension of the perigastric vessels in some of the anterior segments. In *Telmatodrilus* it is the perigastric vessels in the tenth to the sixth setigerous segments which are thus unusually long. Those of the tenth setigerous segment are the longest, and that part which is situated nearest to the dorsal vessel the thickest; that part, again, which is nearest the ventral vessel is vanishingly minute, and any pulsation in this part nearly impossible. Each anterior pair of those perigastric vessels is smaller than the posterior pair, and in the fifth setigerous segment the pair has again assumed its normal size.

In *Ilyodrilus* the perigastric vessels in the nine first setigerous segments

are all slightly pulsating, but none dilated nor differentiated enough to be called a heart. The most posterior of them is the longest and the most anterior one the most minute, just as in *Telmatodrilus.*

The dermal vascular system is always composed of tertiary vessels, mostly emitted from the perigastric vessels, and from them branching into and between the dermal and muscular layers of the body. The dermal vessels in *Limnodrilus Hoffmeisteri* are said to originate direct from the ventral vessel, and from here extend between the layers of the integument.* I have observed a dermal vascular system in *Telmatodrilus*, and in *Camptodrilus corallinus*, and *Claparède* in *Limnodrilus Udekemianus* and *Hoffmeisteri.*

The blood is always yellowish red, more or less dark in different species.

E.—NERVOUS SYSTEM.

The nervous system of *Tubificidæ* resembles the same system of *Lumbriculidæ* and *Enchytræidæ*, the former, however, more than the latter. Along the ventral line of the body and closely attached to the same we find the ventral nerve trunk, in the buccal segment branching itself, forming the œsophagial commissures, again to connect on the upper side of the body in the cephalic lobe with the suprapharyngial or cephalic ganglion.

This ventral ganglionic trunk is composed of two longitudinal and parallel fibrous nerve truncs, more or less fused together, and in every segment surrounded by a ganglionic swelling or agglomeration of cellular ganglionic globules. The cellnuclei in this ganglionic substance are mostly round and regularly defined; only in *Telmatodrilus* we find them more irregular, both in regard to their general form and to the smoothness of their inclosing membrane. In every segment we find one pair of lateral secondary nerves projecting from the ventral nerve cord.

In *Tubificini* the fusion of the ventral fibrous nerve cords is nearly perfect, and the longitudinal space between them, when such one exists, is never traversed by transversal commissures, so common in the true *Polychæta*. In *Telmatodrilini*, however, those nerve truncs are everywhere connected by numerous transversal and ramifying commissures. Both truncs, however, are surrounded by the same ganglionic swellings, no division in the same being perceptible (fig. 1 k; Pl. II).

The most important differences presented by the nervous system of *Tubificidæ* result from the varying form of the cerebral ganglion, and especially its anterior and posterior margins. The concavity of the anterior margins seems in this family, as well as in *Lumbriculidæ*, to be the rule, and in the species I have had opportunity to investigate I have met with only one exception. In *Spirosperma* we find thus the anterior margin to be considerably projected, the ganglionic matter here forming a large conical processus, rivaling in size the rest of the cerebral ganglion.

*Claparède, Recherches Anatomiques, p. 33.

In *Telmatodrilus* the posterior margin of the cephalic ganglion projects in a very sharp angle, and the processus formed is partially forked, perhaps the result of being attached to two different muscular bands.

In all the other species of this family both margins of the cephalic ganglion are concave in smaller or lesser degree, and the differences in the ganglion of the different species are mostly actuated by their own size and form and by that of their lateral cephalic projections.

In some species, such as *Limnodrilus Silvani* and *Limnodrilus alpestris*, the posterior upper part of the cephalic ganglion is sometimes three-lobed. The third or the middle lobe, however, was not present in all the specimens, and never in immature forms.

The lateral globular swellings of the cephalic ganglion of *Ilyodrilus sodalis* are also worthy of mentioning, but for this as well as other minor variations of the ganglion I must refer to the descriptions given under the headings of the different species.

F.—GENERATIVE SYSTEM.

In no class of animals are the generative, or especially the copulative, organs so complicated and so remarkable for their delicate structure as in the family of *Tubificidæ*. These organs consist here, as in other families of Oligochæta, of two classes, viz, *reproductive* and *conductive*. Each of these classes can further be divided into male and female.

The reproductive organs are—

1. Male: Testes.
2. Female: Ovaries.

The conductive or receptive organs are—

3. Male: Efferent duct and copulative organs.
4. Female: Oviducts and receptacles.

Of these the lower end of the efferent duct, or the copulative organ proper, penis, is invaginated in the oviduct, and both form, so to say, one single but rather complicated organ. Both will therefore be considered together.

TESTES.

These organs consist of one or several large, sack-like, amorphous bodies, situated either in front or behind, or sometimes both in front and behind, the cingulum (segment containing the efferent duct and oviduct). In *Telmatodrilus* we find one pair of testes occupying the eighth and ninth setigerous segments, one testicle on each side of the ventral ganglion. In this genus no testes are found behind the cingulum. In *Tubificini* the testes are generally situated behind the cingulum or copulative organs. They consist either of one single sack-like testis, extending through several segments, or of several small ones more or less connected with each other. In *Ilyodrilus sodalis* the testes occupy ten segments, beginning in the twelfth and extending to the twenty-second setigerous segment. They seem in this species not to be connected with each other. In *Ilyodrilus Perrierii* they occupy four seg-

ments, from the eleventh to the fourteenth, and in *Ilyodrilus fragilis* we find them not only in the three first segments behind the cingulum, but also in front of the same.

In *Spirosperma* a large single testis is found in the ninth setigerous segment, occupying that segment and a part of the next or the tenth segment. But also in the eleventh, twelfth, and thirteenth segments are found testes, but here not a single one, but one pair in each segment, or, all in all, seven testes.

In *Psammoryctes*, according to Vejdovsky*, testes are as well found in the eighth setigerous segment as in the eleventh, extending as far back as to the twentieth segment. The testes in this species seem to be single.

In *Limnodrilus* we find the testes generally behind the cingulum, except in the two species described by *Claparède*, viz, *L. Hoffmeisteri* and *L. Udekemianus*, both of which have testes, one in front of the cingulum, or in the eighth segment, and one or two behind the cingulum, or in the tenth, eleventh, and twelfth setigerous segments.

In *Limnodrilus Silvani* we find one pair of testes in the eighth segment, and one single continuous testis behind the cingulum in the eleventh to the fourteenth setigerous segment. In *Limnodrilus ornatus*, as in most of the species, we find testes only behind the cingulum.

In *Camptodrilus igneus* we find one testis extending through the eleventh to fourteenth setigerous segment, and one through the fifteenth and sixteenth ditto. In *Camptodrilus corallinus* the testes form a continuous body from the seventh to the fifteenth setigerous segment.

In *Hemitubifex* we also find a continuous testis extending from the eleventh to the sixteenth setigerous segment. None in front of the cingulum.

The exact number and position of the testes are oftentimes difficult to ascertain, because the different testes seem, at least apparently, to connect with each other, and every attempt to dissect them will often prove unsuccessful on account of their delicate structure. The exact number and position of the testes is also of less importance as a characteristic of the species. The most important point is to know if a testis is found in front or behind the cingulum, or if the testis is single or occurs in pair.

The single testis is the most common one. In pair the testes are found only in three species, viz:

a. In front of the cingulum in *Telmatodrilus* and *Limnodrilus Silvani.*

b. Behind the cingulum in *Spirosperma ferox.*

The testes in all the above species are not much lobed, but almost entire or amorphous. Testes similar to those of *Enchytræus profugus* and *nervosus* and *Pachydrilus* Claparède are not yet observed in *Tubificini.*

OVARIES.

The ovaries in *Tubificidæ* resemble to a great extent those met with in *Enchytræidæ*. They are mostly found in the tenth setigerous segment,

* Ueber Psammoryctes, p.143.

close to the efferent duct, generally in front of the same. In *Telmatodrilus* they extend even into the ninth setigerous segment, and take the form of pear-shaped, sack-like bodies, of a rather larger size than those of other species.

In all the genera of *Tubificini*, except in *Ilyodrilus*, we find the ovaries in the segment of the several porus, but in *Ilyodrilus* they are situated behind the cingulum, and in *Ilyodrilus sodalis* in the nineteenth to the twenty-second setigerous segments, nearly entirely covered by the testes in those segments.

The shape of the ovaries, and the place in the same where the ova develop, vary in different species, to some extent at least, but are not of sufficient constancy to be considered as good genus and species characteristics. In *Spirosperma* the ovaries are very long and broad, sometimes triangular, with an ova developing at their anterior and broadest end. In *Ilyodrilus* we find the ovaries to be plate or dish like, concave, covering the testes like a shell, and developing the ova in one of the margins.

In *Limnodrilus ornatus* the ovary is long, narrow, and ribbon-like; in *Limnodrilus Steigerwaldi*, broad, lobed, and tapering at both ends, with the ova developing in the middle of the organ. In *L. Silvani* the ovaries are extremely long and narrow, thicker at one end than at the other, with the ova also developing at the middle of the ovary. In *Camptodrilus* they are short and narrow, bent in a right angle, with the ova developing in the same. The form, but seldom the place, of the ovary is variable, and, however interesting and important from an anatomical point of view, is of little value as characteristics of genus and species.

EFFERENT DUCT AND COPULATIVE ORGANS.

From the many different opinions and theories, supported by as many different authors, on the true nature of the oviduct and the invagination of the penis into the same, it is pretty evident that the subject is a difficult and important one, and the more interesting because being unique in the animal kingdom. Such eminent investigators as von Siebold,* d'Udekem,† Claparède,‡ and Vejdovsky§ have all advanced the opinion that the penis in *Tubifex*, *Limnodrilus*, &c., is invaginated in the oviduct, and that accordingly both the spermatozoa and the ova are ejected through the *same external porus* by means of two different organs, the penis and the oviduct. All the above investigators have seemingly agreed upon the porus through which the ova should have been ejected, but in regard to the interior opening of the oviduct, through which the ova should enter the same, not two of them have been of the same opinion.

*Vergleichende anatomie, p. 228.

† Histoire naturelle des Tubifex, p. 25.

‡ Recherches anatomique sur les Oligochætes, p. 23.

§ Ueber Psammoryctes Zeitschr. f. w. Zoologie, Bd. xxvii, p. 147.

Other investigators, on the contrary, such as E. R. Lankaster,* oppose the above advanced theories, and state as their opinions that oviducts independent of the penis will eventually be found, being of such a delicate structure that they have as yet escaped detection. In this case all the organs considered as oviducts should only be parts of the efferent duct and penis.

That the investigation of this subject is a difficult one is recognized by both Claparède and Lankaster, and both believe that we will always remain in doubt as to the nature of the oviduct, because direct observations of the passage of the ova through the oviduct must be and are extremely difficult to make. As yet I have not heard of any such observation.

Before I begin to review the different opinions of Claparède, Vejdovsky, and others upon this subject it will be necessary to first shortly describe the different membranes sheaths, and muscles which I have found to belong to the copulative organs, and some of which I believe must belong to the oviduct.

The male organ consists in well-developed specimens of two different parts, viz:

a. Efferent funnel, efferent duct, atrium with prostata and penis.

b. Penis sheath.

The different parts under *a* are all connected with each other, and constitute what is generally known as the "efferent duct." Not so with the penis sheath, which can be considered, in a fully developed specimen, as an accessory organ; surrounding the penis proper at its lower end, and being open at both extremities, is connected with the penis only, if at all, by minute muscles.

The efferent duct, with its funnel-shaped aperture, is, next to the atrium, the least variable part of the copulative organ, and constitutes always the upper part of the organ, and is in our present family of *Tubificidæ* always single. The middle part, or atrium, of the copulative organ is always thicker and somewhat bent, and furnished with either one single prostata gland, as in *Tubificini*, or with several ones, as in *Telmatodrilini.* The cells of the atrium are generally large and distinct, and quite different from those of the efferent duct proper. The interior of the efferent duct is coated with a ciliated epithelium, but in the atrium, or penis proper, this is absent.

The lower end of the atrium is tapering towards the exterior apex, forming the penis proper. The penis is somewhat differentiated, the cells sometimes having a more regular form and arrangement than those of the atrium. Where, however, the atrium ends and the penis proper begins is impossible to decide upon, as the change from one organ to the other is very gradual, and sometimes even none at all. When the atrium has entered the penis sheath and the oviduct it may, however, be considered as a true penis.

* Ann. and Mag. of Nat. Hist., Vol. VII, p. 90-100.

The penis is sometimes, not always, surrounded by a penis sheath, chitinous and generally of a cylindrical form, which, more than any other, seems especially adapted to strengthen the organ and direct its course at copulation. The penis sheath is situated outside the penis, surrounding the same, and if any connection between them exists it is only through minute muscles.

As female organ or oviduct I consider several sheaths surrounding the penis sheath, and generally resembling this latter, both in form and length, the width, of course, being larger. The interior of those sheaths incloses always the penis sheath tightly, and resembles the same both in form and size. It is sometimes chitinous, sometimes muscular, sometimes even entirely wanting. Both its extremities are free, neither connected with the atrium nor with the body wall. Its interior surface is never connected with the penis sheath, but both have evidently free motion, one outside the other. I have called this sheath "the interior sheath of the oviduct," or sometimes shortly "the interior oviduct." When it is absent I have called the oviduct "single;" when present, "double."

The exterior oviduct generally consists of a large, sack-like organ, surrounding the inner sheath entirely. One end of the same is always attached to the body wall all around the genital porus. The interior aperture is free in one respect, viz, that it is not directly connected with any parts of the atrium, penis sheath, or interior oviduct. With the body wall, however, it is nearly always connected by longitudinal, circular, or spiral muscles. This organ I consider as the true oviduct, and its inner aperture, which is always to be found in the neighborhood of the aperture of the inner sheaths, as the true inner aperture of the oviduct, through which the ova enter the same, after having been freely suspended in the perigastric cavity of the cingulum.

After having entered the inner aperture I have reason to believe that they pass between the inner and outer sheaths of the oviduct towards the exterior genital porus. The muscles, nearly always surrounding the exterior oviduct, are often so numerous that they obscure that organ entirely, or at least make it very difficult to discover its inner aperture.

In the different figures appended to this paper the following abbreviations are used: p.=penis; p. s.=penis sheath; ovd.=oviduct; ex. ovd.=exterior oviduct; in. ovd.=interior sheath of the oviduct; atr.=atrium; eff.=efferent funnel; effd.=efferent duct; in. aptr.=interior aperture; ex. aptr.=exterior aperture; pr.=prostate gland, and g. p.=genital porus. As figures for reference I would suggest figures: 1*e*; 2*h*; 3*h*; 5*g*; 6*c*; 9*c*; 10*e*; 10*f*; 12*g*; 15*a*; 16*a*, in which the different parts of the copulative organs as described above are delineated.

After this preliminary review of the copulative organs as I have understood them, we may return to a perusal of the same organs as they have been described by Claparède and Vejdovsky.

Claparède, in his celebrated and excellent work "*Recherches Anatomiques sur les Oligochètes*," describes three species of worms belonging to the family of *Tubificidæ*. Of these, two species are named *Limnodrilus*, a genus here for the first time introduced, and one classified in the old genus *Tubifex*. *Tubifex Bonneti*, as being the best known species in the genus, can evidently serve as type for the same. This species is also the best described and figured of the three, and for this reason I believe that Claparède studied the same last of all.

If we turn to the above-mentioned work (Pl. II, Figs. 1, 3, and 4), we find here not less than three different delineations of the copulative organs proper, and as far as I can judge his drawings of this species correspond more with my general description of the copulative organs than with his own. In the above Fig. 4, *c* is evidently the lumen of the penis; *f* the lower end of the penis sheath, the upper end of which is not seen; *l* is the lower or exterior orifice of the interior oviduct, the upper end or interior orifice of which is plainly drawn, but not marked with any letter of reference. Between *g* and *b* is seen a circular line, which I believe must indicate the exterior orifice of the exterior oviduct. The upper end of this oviduct is not seen in the drawing. In Fig. 1, which represents the same organ, we find the interior orifice of both oviducts, the exterior one being represented as seen in optic section. What I here have designated as the exterior oviduct is by Claparède represented as being a cloaca, and is in all the figures delineated as being continuous with two longitudinal trunks of muscles outside the same. That they, however, are entirely separated from the former is quite certain, and I have also figured them as such whenever they have been present, which, however, has not been the case in every species. According to Fig. 3 the exterior coating of the atrium *e* ends somewhere near b^1, and does not inclose the oviducts. This is also in conformity with my own observations of the development of the oviduct and penis (see Figs. 17 and 18.)

If this is the case, and (in Claparède figures) if *e* does not inclose the oviduct *m*, *b*, and *g*, why could not the true interior aperture be found at b^1, and the ova enter through the same? The aperture at b^1 is evidently there for some purpose, and it is most reasonable to consider it the aperture of the oviduct. But, according to Claparède, the interior aperture should be looked for much higher up, near the upper end of the atrium, just at its junction with the efferent tube proper. A more inconvenient and difficult entrance for the ova could hardly be found, it not only being very small, but, worst of all, is covered by the prostate glands. It is true that the exterior layer of the atrium ends at the base of the efferent duct proper, but I have not been able to see any aperture here, and cannot imagine which power or which muscles should convey the ova towards the genital porus. Further on I will explain why the exterior coating of the atrium ends here and is not continued round the efferent duct.

If we now turn to Pl. I, Figs. 4 and 1, we find here representations of the copulative organs of two different species. It is most reasonable to suppose that the copulative organs of the species in the same family are formed in the same principal way, and that no very large variations will occur in nearly related genera. If, therefore, the exterior coating of the atrium in one species ends above the oviduct, it is also reasonable to suppose that it will do the same in other species of the same family.

According to the drawings of Claparède this is, however, not the case. In the figures last referred to the penis sheath is seen in both, but instead of inclosing the penis, or lower end of atrium, it is represented as inclosed in the same. The oviduct is seen as if connected with the exterior coating of the atrium, and any organ resembling the oviduct as figured for *Tubifex* is not to be found. This, however, is in full accordance with the description.

To me it appears that Claparède, in studying the *Tubifex*, really discovered the nature of the oviduct, but misunderstood it in trying to reconcile its aspect with his old ideas and those of previous investigators. Why the exterior coating of the atrium should be considered as an oviduct I cannot readily see. It would be far more natural to think that both the spermatozoa and the ova were captured by the same funnel-shaped organ and conveyed through the efferent duct to the genital porus. Besides, if the exterior coating of the atrium is considered as the oviduct, what then are all the peculiar funnel-shaped organs surrounding the penis and the penis sheath?

The copulative organs of *Psammoryctes*, as described by Vejdovsky,* exhibit some characteristics similar to those of *Tubifex*, as they are understood by Claparède.

In Fig. 9, Taf. VIII, the ovd. represents evidently the exterior sheath of the oviduct, and the lower bell-shaped organ surrounding the penis and connected with the atrium is perhaps the interior sheath of the oviduct. The interior aperture is, however, not delineated, and must, I think, be sought for in the neighborhood of *g b*. If such an aperture really exists, the whole organ resembles, to a considerable extent, not only the same of *Tubifex Bonneti*, but also that of the most of the new species described in this paper, especially so *Tubifex Campanulatus*. According to the above figure the ova pass between the exterior oviduct and what I have designated as the interior sheath of the same. I have myself had no observation on this point, and must reserve my opinion until some future time.

We will now again return to our new species, and more minutely review their copulative organs and compare them with each other and with those of formerly known species.

In a preliminary report† on this subject I stated as my opinion that

* Zeitschrift f. w. Zoologie, Bd. xlvii. Ueber Psammoryctes.

† Preliminary report on genera and species of Tubificidæ, by Gustaf Eisen. Bihang till k. Svenska Vet. Akad. Handlingar, Band 5. No. 16. 1879.

the most primitive and simplest oviduct was found in *Telmatodrilus*, and that it here consisted merely of a fold of the body wall. Investigation of a larger number of species, however, has led me to considerably change my former views, and the discovery of a minute penis sheath even in this species is evidence that the penis and oviduct here are just as complicated as in the subfamily of *Tubificini*.

The oviduct of *Telmatodrilus* (Fig. 1, *c*, ovd.) consists of a large, heavy, opacous, muscular sack, inclosing the whole of the interior penis. One end of the same is attached to the body wall all round the genital porus. The other end is free, but its aperture is not clearly defined, and so surrounded by muscles that all observation is very difficult. The oviduct in this species is single.

In *Tubificini* the oviduct always consists of a more or less sack-like organ, extending from the genital porus towards the interior of the body. In the species of *Tubifex* this organ is broad and rounded; in *Camptodrilus* elongated and narrow. In *Limnodrilus* and *Camptodrilus* the interior aperture of the oviduct is extremely narrow, inclosing the atrium tightly, at least when the animal is dead, and the most careful observation is needed to detect it at all. In *Hemitubifex*, *Tubifex*, *Spirosperma*, and also in some species of *Ilyodrilus*, this aperture, however, is wide and easily detectable. In many instances the oviduct is funnel-shaped, and sometimes the widest opening turned toward the body wall, as in *Ilyodrilus sodalis*. In other species, such as *Hemitubifex* and *Ilyodrilus fragilis*, the contrary takes place. In *Ilyodrilus sodalis* the membrane of the oviduct is full of very minute spicula irregularly distributed. Such spicula are also found in the oviduct of *Psammoryctes*, but here only at the upper end of the organ where it touches the atrium proper. The exterior oviduct is more or less chitinous, but also muscular, as in *Spirosperma* and *Ilyodrilus Perrierii*.

An interior sheath between the oviduct and the penis sheath, or what I have designated as a double oviduct, is found in many species. We find it thus in all the species of *Limnodrilus* except in *L. ornatus*. In *Camptodrilus* we find it only in *C. spiralis*, but not in any other species of the genus. The oviduct is also double in *Hemitubifex*, *Tubifex*, and *Ilyodrilus Perrierii*. This interior sheath of the oviduct is free at both ends, and not directly connected with the body wall. In *Camptodrilus spiralis*, *Limnodrilus alpestris*, and *L. monticola* this interior sheath is chitinous, and resembles closely the form of the penis sheath, which it incloses. In *Limnodrilus Steigerwaldii* it is decidedly muscular, composed of numerous layers of concentric muscles of apparently great strength. In *Hemitubifex* the exterior and interior sheaths of the oviduct are exactly of the same form as the penis sheath, or funnel-shaped, but of course of different sizes, as the one is inclosing the other.

The exterior oviduct is always more or less surrounded by muscles. Generally these are longitudinal, and attached either to the exterior surface of the oviduct, and in this case of a greater number, or to the

upper and interior surface of the oviduct, but in this case consisting only of two main longitudinal trunks. Such muscles are found in *Tubifex*, *Ilyodrilus fragilis*, and *Hemitubifex*, but not in any species of *Limnodrilus* or *Camptodrilus*.

In *Limnodrilus Silvani* and *Hoffmeisteri* we find the oviduct surrounded by circular or concentric muscles. In the former species, however, they are very few. In the genus *Camptodrilus* we find the most characteristic feature to be the large spiral muscles surrounding the oviduct. They are of an enormous length, many times longer than the oviduct, around which they wind themselves several times. The exterior end of these muscles are attached to the body wall, near to the genital porus, but the interior one to the lower part of the oviduct. We get the best idea of these muscles if we to the blunt end of a lead-pencil attach a number of equal threads and afterwards wind them spirally round the pencil towards the pointed end and from here return towards the blunt end again, always winding the threads in the same direction, or towards us.

In some instances it seems as if the spiral muscles were wound round the oviduct several times; in others again as if only twice.

The work such muscles can perform may be easily understood. The upper end of the plexus is funnel-shaped, and, as it seems, eminently adapted to capture the ova, and when once captured a few successive contractions may suffice to push them towards and through the sexual porus.

In different species said muscles are found to be of very different size. In *C. spiralis* they are so minute and fine that careful searching is necessary to detect them; but in other species, however, their strength and thickness make them easily discernible. The occurrence of such muscles is unique, not only in the class of *Oligochæta*, but also, as far as I know, in the whole animal kingdom.

EFFERENT DUCT.

The efferent duct is less subject to variation than any other part of the copulative organ.

We distinguish of the same, however, two different types, viz:

a A short and broad tube, found in the genus *Ilyodrilus*, and similar to the same organ of *Mesenchytræus* of the family *Enchytræidæ*.

b A longer and more slender tube, found in all the other genera, and corresponding in form to the same organ of *Archienchytræus* and *Neoenchytræus* of the family above referred to.

In *Ilyodrilus sodalis* we find the form intermediate between the two, not quite so broad and short as in the two other species of the genus, but also far from reaching the relative length of the same organs of the other genera of *Tubificidæ*. In *Telmatodrilus* the efferent duct is unusually short, but also correspondingly narrow.

The inner end of the efferent duct is always furnished with a large

funnel-shaped orifice, especially adapted for capturing the spermatozoa. This efferent funnel is mostly covered along its inner surface with vibrating cilia, protruding far outside its exterior margin. In *Limnodrilus alpestris* and *Camptodrilus spiralis*, however, the cilia must either be very minute or entirely absent, as I have repeatedly failed to observe them, at least in the margin of the funnel. The funnel cilia of *Hemitubifex* are longer than the funnel. The exterior of the efferent funnel is in *Ilyodrilus Perrierii* covered with dark oblong glands. In some species, such as *Spirosperma*, etc., the cells composing the funnel are large and plainly visible; in others again, such as *Ilyodrilus fragilis*, only the cell-nuclei can be seen.

The main body of the atrium consists of two separate layers or coatings, one overlaying the other. Only the interior one of those extends clear down to the apex of the penis. The exterior one, on the contrary, does not extend farther than to the upper end of the penis sheath, and ends here somewhat abruptly. Its lower continuation, from which it was easily separated, forms the exterior sheath of the oviduct when such a sheath is present. When not present, it must either have been absorbed or grown together with the interior oviduct, and forming what I have here mentioned under the name of a single oviduct. Further ahead in this paper I will endeavor to show how such separation has taken place and in what way the oviduct has originated.

The form of the oviduct varies some in different genera, but not enough to furnish good genus characteristics. In *Telmatodrilus* the atrium is cylindrical, bent like a crescent, but not tapering towards the ends. The atrium in this family is furnished with several distinct prostate glands, cropping out, as it were, on all sides of the atrium. In *Tubificini* the form of the atrium is less regular, and resembles more an oblong sack, more or less tapering towards both ends, especially towards the penis. In *Tubifex* this lower part of the atrium is shorter than in any other genus. In *Limnodrilus* it is longer—longer even than the upper part, which is swelled. In *Ilyodrilus* the atrium is very irregular and its form inconstant. In the same species it is sometimes considerably extended, sometimes again contracted in length, and constricted in several different places, however without forming anything like a "*vesicula seminalis.*"

From this general form of the atrium we meet with two notable exceptions: the one in *Psammoryctes*, the other in *Hemetubifex*. In both these genera the upper end of the atrium, which carries the prostate gland, is enlarged and perfectly globular, and at least in form distinct from the other part of the atrium. In *Psammoryctes* the lower end of the atrium, or that part which is situated between the "globular chamber" and the penis proper, is long, narrow, tube-like, and not glandular.* But, according to E. Ray Lankaster, this peculiar tube should resemble the corresponding part in *Limnodrilus*. If this is the case the tube must

* Vejdovsky, Ueber Psammoryctes, p. 145.

certainly also be glandular and be no exception to the rule, and the difference should then only refer to the form or perhaps pellucidity of the organ. According to Vejdovsky, who calls this organ "kittgange," anything similar should not be found anywhere else, not even in *Limnodrilus*, and would in such a case, together with the globular chamber, form an accessory organ entirely distinct from the atrium. I am satisfied, however, that this is not the case, and think that the two parts just referred to, the circular chamber and the pellucid tube, constitute nothing else than the atrium proper. And that part to which Vejdovsky has given the name of atrium proper is evidently nothing else than the upper part of the penis proper. When we in all the other species of *Tubificidæ* assign the name of atrium to that part of the efferent duct which supports the prostate gland, why should we give it another name in *Psammoryctes* only because it here has a somewhat different form? Is it not easier to imagine that an old organ has been modified than to believe that a new one has been added?

In *Hemitubifex* we meet with an atrium of somewhat similar shape. The upper end of the same, close to the efferent duct proper, is also globular and supports the prostate gland, and is, as far as I can judge from figures and descriptions, entirely homologous to the same organ of *Psammoryctes*. The narrower part of the atrium, however, is not quite so regular and tube-like as in this latter genus, but the homology of the organs seems evident. Also, in *Hemitubifex* this lower part of the atrium is less glandular than the circular chamber, but this is also the case in nearly all the species I have investigated and is not characteristic of the genus. That part of the organ which corresponds with what Vejdovsky calls "*atrium*" is, at least in *Hemitubifex*, nothing else than the upper part of the penis proper.

The figures will in every instance give a better idea of the organs in question, and I must therefore mainly refer to them. (For Hemitubifex see Pl. VII, Fig. 6 *c*.)

In *Tubificini* we find the atrium furnished with only one single-lobed prostate gland, the form of which only varies little in the different species. It always takes the shape of a more or less sponge-like, or even fan-shaped, body, the latter when seen in optical section. The size of the cells composing the prostate varies in different species, but not enough to furnish species characteristics.

If we now turn to the last remaining part of the copulative organ, the penis proper, we will find it of considerably different form in the different species. The most common form of the penis is that of a long, narrow cylinder, tapering towards its exterior apex. The exterior apex of the penis is either rounded, as in *Camptodrilus* and certain species of *Limnodrilus*, or truncate, as in *Limnodrilus monticola*. In *Limnodrilus Steigerwaldii* the apex of the penis is considerably swelled; in *Limnodrilus Silvani* the penis is swelled above the apex. In *Hemitubifex* and *Psammoryctes* the upper end of the penis is considerably enlarged above

the penis sheath, and in the latter species this part has, as I think incorrectly, been considered as the atrium proper. In *Spirosperma* the lower end of the penis is composed of very large octagonal or rounded cells, quite different in form and size from those which constitute the upper part of the penis and lower part of the atrium, but more resembling those of the upper part of this organ.

Penis is surrounded by a sheath of chitinous consistency in all the genera of the family, except in *Ilyodrilus*. In *Ilyodrilus Perrierii*, however, we meet with a chitinous sheath, but it is difficult to decide upon whether this sheath should be referred to the oviduct or to the penis.

The penis sheath is nearly always free at both its ends, and never attached to the body wall. The shape and relative size of the sheath is always of the utmost importance as characterizing the species; but as I have in a former part of this paper more minutely described the same, it will now suffice to point out the few principal forms under which all other may be arranged.

The upper end of the penis sheath is always free; the lower end is free in *Tubificini*, but is in *Telmatodrilini* connected with the apex of the penis proper. That this latter is a more primitive form of the penis is evident, as in undeveloped specimens of *Tubificini* the penis sheath is always connected with the penis itself, and separates from the latter first in a later stage of development. But to this I will return further on. In *Telmatodrilus* the penis sheath is funnel-shaped, the interior end being the widest. In *Tubificini* the form of the sheath is either that of a funnel, as in *Hemitubifex* and *Ilyodrilus Perrierii*, or tube, cylindrical, or trumpet shaped, as in the most of the species of *Limnodrilus* and *Camptodrilus*. In *Limnodrilus Silvani* we meet with an aberrant form, its penis sheath taking the shape of an arrow-head, at least when seen from the front. The upper end of the penis sheath is in *Limnodrilus ornatus* furnished with a ring of star-like glands, the functions of which are not understood. Generally the penis sheath covers the penis clear to apex, but in *Spirosperma* and *Limnodrilus Steigerwaldii* the penis protrudes considerably beyond the sheath.

In adult specimens of *Telmatodrilus* the penis appears to be constantly projecting through the genital porus, but in *Tubificini* this projection takes place only during copulation. This sexual porus is always found in the tenth setigerous segment, and in *Tubificini* just in front of the ventral spines, but in *Telmatodrilini* between the spine fascicle and the ventral ganglion.

DEVELOPMENT OF THE COPULATIVE ORGANS.

Vejdovsky, in his most beautiful work, *Monographie der Enchyætriden*,* gives evidence of the development of the efferent duct and copulative organ in that family. It is only natural to suppose that the course of development of such an important organ as the *efferent duct* should be

* Plate I, Fig. 12.

about the same in two so nearly related families as *Enchytrœidœ* and *Tubificidœ*, the much more so because if we consider the same development of this organ to take place in both families it would at once explain the invagination of the oviduct in a most easy and, as it would seem, most natural way. The oviduct, once formed by an inturning of the body wall, would easily have been invaginated by the efferent duct, originated on and projecting from the septal tissues of a neighboring segment. Its exterior end, instead of connecting with the body wall, would then merely remain suspended in the oviduct, or perhaps even later be connected with this organ through accessory muscles.

However plausible such a theory may seem, and however easily it may explain one of the most complicated anatomical facts, my own observations have necessitated me to reject the same; and I will in the following endeavor to demonstrate the course of development of the copulative organs in *Tubificidœ.* The species I have studied for this purpose were *Limondrilus alpestris*, *L. corallinus*, and *Telmatodrilus.* The first named of this species was especially favorable for observation.

The first sign of the efferent duct I find to be a small glandular, or at least cellular, agglomeration, situated on the body wall of the tenth setigerous segment, one on each side of the ventral nerve, and exactly on the place where in a future stage of development the genital porus will be found. (Figs. 18 *a* and *b*.)

This cellular agglomeration is convex, and in shape somewhat resembling a raspberry. When viewed from above it will be found to consist of two different layers, one exterior or cortical (Fig. 18 *a:* cr. l.), and one interior (in *l*). In the same specimens I looked in vain for any agglomeration of cells on the septal tissues which could be considered as the first beginning of the efferent duct.

In a further advanced stage this primary agglomeration is found to have increased in size towards the perigastric cavity, and assumed the form of an oblong body, tapering slightly towards its free interior end. Both the interior and exterior layers are now more differentiated, the former one being more or less transversely striated and the latter seemingly composed of longitudinal tissues (Fig. 18 *c*). The cortical layer is also seen to be covered by a minute coating of pellucid cells, and the interior cellular mass is pierced by a narrow lumen or canal, the future seminal duct.

When this large glandular body has reached a certain size or a certain stage of development, it opens at the top and the interior matrix grows out and forms a long and narrow tube, the future efferent duct proper.

In more advanced specimens this tube is found to be connected with the septal tissues, and its interior end furnished with a large circular body, considerably flattened, and composed of large round cells. This round body is situated on the other side of the dissepiment, and evidently the first beginning of the efferent funnel (Fig. 18 *f*). The way

this efferent duct is developed from the interior matrix of the sexual gland explains at once why it has one coating less than the atrium, the exterior coating of the latter being the original cortical layer of the primitive gland.

Thus the efferent duct and copulative organs are exteriorly modeled long before their interior parts are in any more advanced state of differentiation. In maturer specimens we find the first signs of such a differentiation to be a bursting of the cortical layer somewhere midway between its base and top (Figs. 18 *d:* x, 18 *g:* c, 18 *h:* ap. ps.), and shortly afterwards a hoof-like line is perceived in the interior of the inner matrix, the convexity of the line being turned towards the sexual porus (Fig. 18 *d:* xx). At the same time another fissure is seen to extend from the opening in the cortical layer towards the interior of the inner layer or matrix, without, however, uniting itself with the hoof-like line (Fig. 18 *d:* *f*). This first-mentioned hoof-like fissure is only the outline of a cavity, which, developing, shortly fills the larger part of the interoir matrix, and as yet communicates with the exterior only through the lumen leading to the sexual porus.

This cavity I consider as the beginning of the future oviduct. That part of the matrix which surrounds the cavity, and which is directly inclosed by the cortical layer, is destined to become the oviduct proper; that part, on the contrary, which is surrounded by the cavity becomes the penis proper and its sheath (Fig. 18 *g:* ca. = cavity, p. = penis, ps. = penis-sheath, and ovd. = oviduct).

When this cavity has reached a certain development all connection between the oviduct and the penis proper is severed at the top of the former (Fig. 18 *h:* in. ap.), or just inside the first circular fissure in the cortical layer.

Gradually a penis sheath is separated from the main body of the penis by the further extension downwards of the above-mentioned vertical fissure (Fig. 18 *g:* *f*; Fig. 18 *h:* *f*). To begin with, this fissure does not reach the cavity of the oviduct, and the primitive penis sheath remains connected with the penis at the exterior apex. Further on, however, this connection is fully severed in species of the subfamily *Tubificini*, but in *Telmatodrilini* this connection remains even in the highest developed specimens, and forms one of the principal characteristics of this family (Fig. 17 *a:* ps.).

The penis sheath, when first separated, is very thick and cellular, but is finally partially absorbed and assumes a chitinous consistency; even the oviduct decreases in thickness, at least in the species of *Tubificini*. In species with a double oviduct, the cortical layer remains separated from the interior oviduct, and forms the exterior sheath of the oviduct, but in species where the oviduct is single I believe the cortical layer and the interior oviduct to have grown together to form the final single oviduct. Even the pellucid epithelium, which once surrounded the cortical layer, is absorbed, leaving the entrance to the oviduct free (Fig. 18 *h:* in. ap.).

The atrium and prostate gland are, to begin with, entirely surrounded by the cortical layer, and the prostata evidently develops only from the interior matrix. While developing they burst through the cortical layer, which remains as the exterior coating of the atrium (Fig. 17 *a:* ps.).

From the above investigations, imperfect as they are, I think the following facts can be considered as established:

1. The oviduct, atrium, and penis proper do not originate on the septal tissues; but
2. Develop from a large gland which originates on the body wall.
3. The oviduct and penis are originally united.

RECEPTACLE.

The receptacles are found in the ninth setigerous segments, and consist of two more or less sack-like bodies, one on each side of the ventral nerve trunk, and are in *Tubificini* attached to the body wall just in front of the ventral spine fascicles, but in *Telmatodrilini* between the ventral and dorsal fascicles. In *Lumbriculidæ* the receptacle opens behind the ventral spines, and in *Enchytræidæ* between certain segments. Of the receptacles we can distinguish three different forms, which, however, are connected by numerous intermediate ones. The most simple form of the receptacle is that of a sack, gradually increasing in size from the external porus to the internal apex. Such is the form in *Telmatodrilus* and in certain species of *Camptodrilus* and a few other genera. The upper end of such a receptacle is sometimes bent.

In other species we find the receptacle to consist of two unequal parts, the lower one of which is tube-like and narrow—a mere duct for the spermatozoa. The upper or inner part, on the contrary, is generally enlarged and bent, and serves mainly as a receptacle proper. Such a form is met with in *Tubifex campanulatus*, *Ilyodrilus Perrierii*, *Ilyodrilus fragilis*, and in *Spirosperma*, in which latter genus it reaches an unusual size, extending as it does through several segments. In its highest developed form the receptacle consists of three different parts, one upper sack-like or receptacle proper, one middle narrow tube, and one lower muscular part situated nearest the external porus. Such receptacle is found in *Hemitubifex insignis*, *Limnodrilus alpestris*, and *L. Silvani*. Intermediate forms are found in *Ilyodrilus sodalis*, *Limnodrilus ornatus*, &c.

The base of the receptacle is furnished with accessory glands only in two species, viz, *Ilyodrilus sodalis* and *Hemitubifex insignis*. In the former species we meet with only one single gland at the base, in the latter with three for each receptacle (Fig. 5 *h* and Fig. 6 *e*).

I have as yet found spermatophores only in few species, but am inclined to believe their occurrence to be the rule rather than the exception. Of the spermatophores we can distinguish three different forms, viz:

a. The spermatophore is shuttle-like, generally tapering toward one

end. The tails of the spermatozoa extend outside of the main body of the spermatophore.

In some spermatophores the tails are more numerous in one end than in the other. (See *Limnodrilus Silvani* and *L. alpestris.*)

In *Tubifex campanulatus* the spermatophore was surrounded by a large pellucid bag, which, perhaps, also may be the case in other species.

b. The spermatophore is more cylindrical and not covered with the tails of the spermatozoa. Such is the spermatophore of *Tubifex coccineus.**

c. The spermatophore extremely long and narrow, coiled into a kind of spiral and surrounded by a large pellucid membrane. The exterior is here seemingly divided in numerous oblique segments. Such a spermatophore is found only in *Spirosperma.*

The form of the spermatophores is more or less variable, and can only exceptionally be of any value as a specific or generic characteristic. Only in *Spirosperma* the spermatophores appear to be of a more constant form, and in fact resemble each other closely.

G.—SEGMENTAL ORGANS.

The segmental organs in *Tubificidæ*, and in fact in all the families of *Oligochæta*, open in front of the ventral spines. They are found in all the setigerous segments, except in 1st to 5th or 1st to 6th, and in 8th to 10th or even 8th to 11th. It is evidently this absence of segmental organs in those segments which are occupied by the sexual conductive organs which first gave impulse to the theory advanced by Claparède and others that the conductive sexual organs were nothing else than modified segmental organs. Vejdovsky† has, however, shown that in *Enchytræidæ* the conductive sexual organs have a quite independent origin, and considers the same to be the case even in *Naididæ.* It seems out of the question to assume that the segmental organs and *receptaculum seminis* are homologous anywhere in this class of Anelida, as there is little doubt as to their different origin, but concerning the efferent duct the question must as yet remain open, no direct observations having been made on the origin and development of the segmental organs of *Tubificidæ.* The efferent duct in this family seems to originate and develop on a quite different way from what it does in *Enchytræidæ*, and when this is the case the relationship between those respective organs and the segmental organs may also be quite different in the different families, and in any case we must regard the question as as yet unsettled and requiring a good deal more direct observation than I have had opportunity to make. I hope at a future time to be able to return to this subject, and will at present restrict myself to a description of the organs in question as they are found in this family.

The segmental organs of *Tubificidæ* resemble those of *Lumbriculidæ*

* *Vejdovsky;* Ueber Psammoryctis, Taf. VIII, Fig. 13.

† *Monographie der Enchytræiden*, page 40, &c.

and also those of *Enchytræidæ*, but those latter, however, to a lesser degree. The general form of these organs is in the first two of the above families exactly the same, and with *Enchytræidæ* the only difference is that the tube there is surrounded by one single mass of granulated or glandular matter, giving the whole organ a more compact consistency. In *Tubificidæ*, as well as in *Lumbriculidæ*, the duct is comparatively free, and only in *Limnodrilus alpestris* have I found a tendency to cellular agglomeration, as a few windings of the duct are here surrounded by a common cellular matrix.

The tube of the organ is sometimes surrounded all along by numerous oblong or round cells, more or less inflated, always pellucid, and sometimes furnished with a very conspicuous nucleus. Such globular cells are found in *Telmatodrilus Vejdovskyi*, *Limnodrilus alpestris* and *L. Hoffmeisteri*, *Camptodrilus corallinus*, and *C. igneus*. In *L. Hoffmeisteri* and *Limnodrilus alpestris*, and also in *C. corallinus*, they are found only on those segmental organs which are situated in front of the cingulum, but in the other species also on those situated behind the same.

Such pellucid cells are also found attached to the segmental organs of *Rhynchelmis*,* of the family of *Lumbriculidæ*.

The tube at the base of the interior aperture of the segmental organ is sometimes surrounded by glandular agglomerations of mostly a brownish or yellow color. Such agglomerations, however, are rarely met with, and I have encountered them only in *Camptodrilus igneus*. By Clarapède they are described in *Limnodrilus Hoffmeisteri* and *L. Udekemianus*.

In *Lumbriculidæ* they are found in all the genera except *Ochnerodrilus*, and in *Enchytræidæ* in *Enchytræus puteanus*, *lobifer*, and *Leydigii*.

In *Ilyodrilus fragilis* the wall of the tube below the funnel-shaped aperture was found to be considerably enlarged, or, perhaps, rather covered by several large cells, each with distinct nucleus. But the rest of the tube did in nothing particular differ from the general form.

FRESNO, CAL., *March* 15, 1880.

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* *Vejdovsky:* Anat. Studien an Rhynchelmis, page 346.

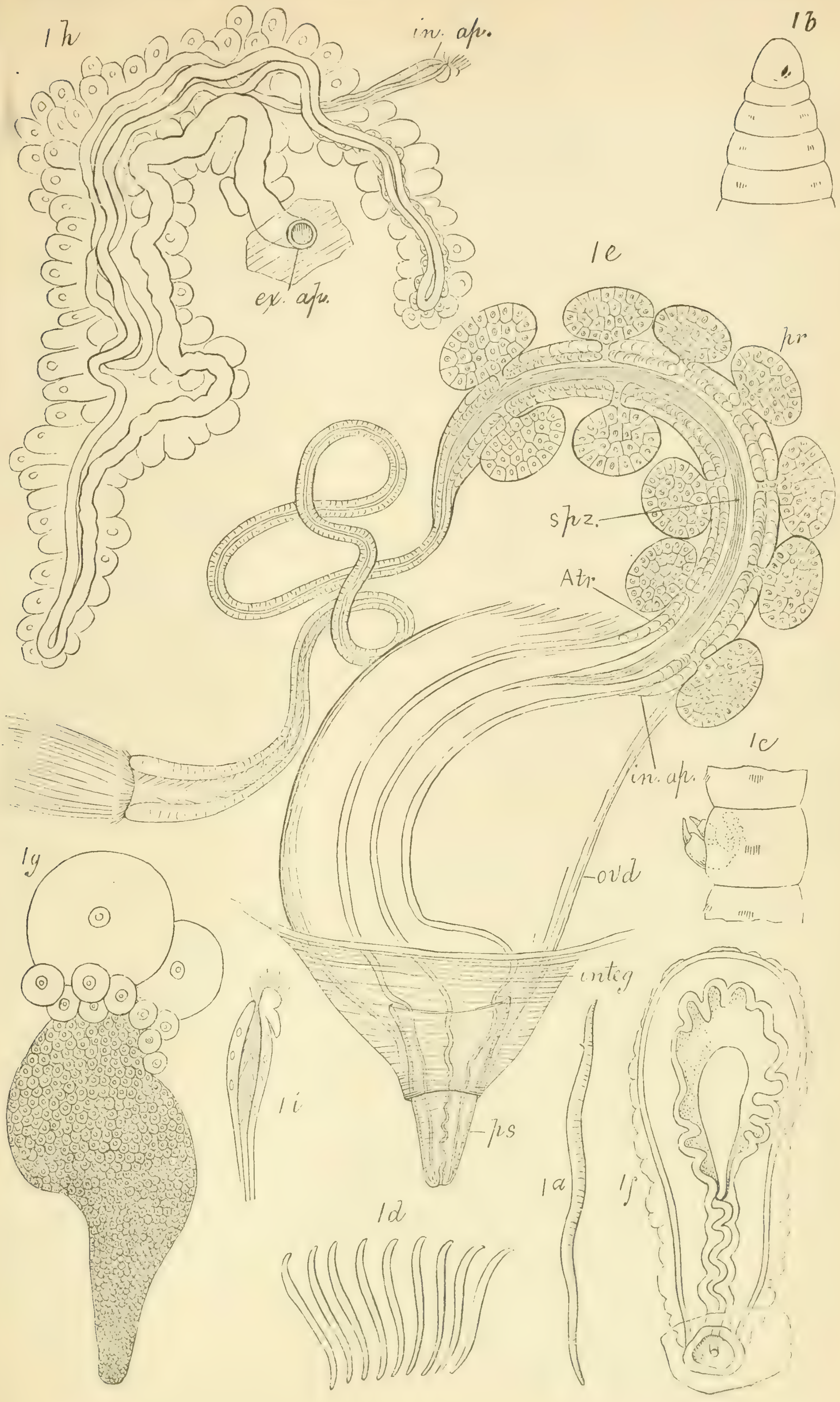
EXPLANATION OF THE REFERENCE LETTERS USED IN THE PLATES.

atr.—Atrium.
eff.—Efferent duct.
eff. f.—Efferent funnel.
p.—Penis.
p. s.—Penis sheath.
ex. ovd.—Exterior oviduct.
in. ovd.—Interior oviduct.
in. apt.—Interior aperture.
ex. apt.—Exterior aperture.
sp. mscl.—Spiral muscles.
pr.—Prostate glands.
sp.—Spines.
v. v.—Ventral vessels.
d. v.—Dorsal vessel.
n. s.—Natural size.
h. mgfd.—Highly magnified.
ovd.—Oviduct.
s. bc.—Buccale segment.
l. cep.—Cephalic lobe.
f.—The first fissure between the penis and the penis sheath.

EXPLANATION OF PLATE I.

FIG. 1.—TELMATODRILUS VEJDOVSKYI.

Fig. 1 *a*.—The worm, natural size.
1 *b*.—The anterior part of the worm.
1 *c*.—The 10th setigerous segment, showing the exterior penis.
1 *d*.—A fascicle of spines, h. mgfd.
1 *e*.—The efferent duct, atrium and penis, and oviduct. The prostate glands are seen surrounding the atrium. The muscles surrounding or constituting the oviduct are not represented.
1 *f*.—One of the receptacles in the ninth setigerous segment.
1 *g*.—One of the ovaries; at its upper end are seen some ripe ova.
1 *h*.—One of the segmental organs.
1 *i*.—The interior aperture of the same, highly magnified.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EXPLANATION OF PLATE II.

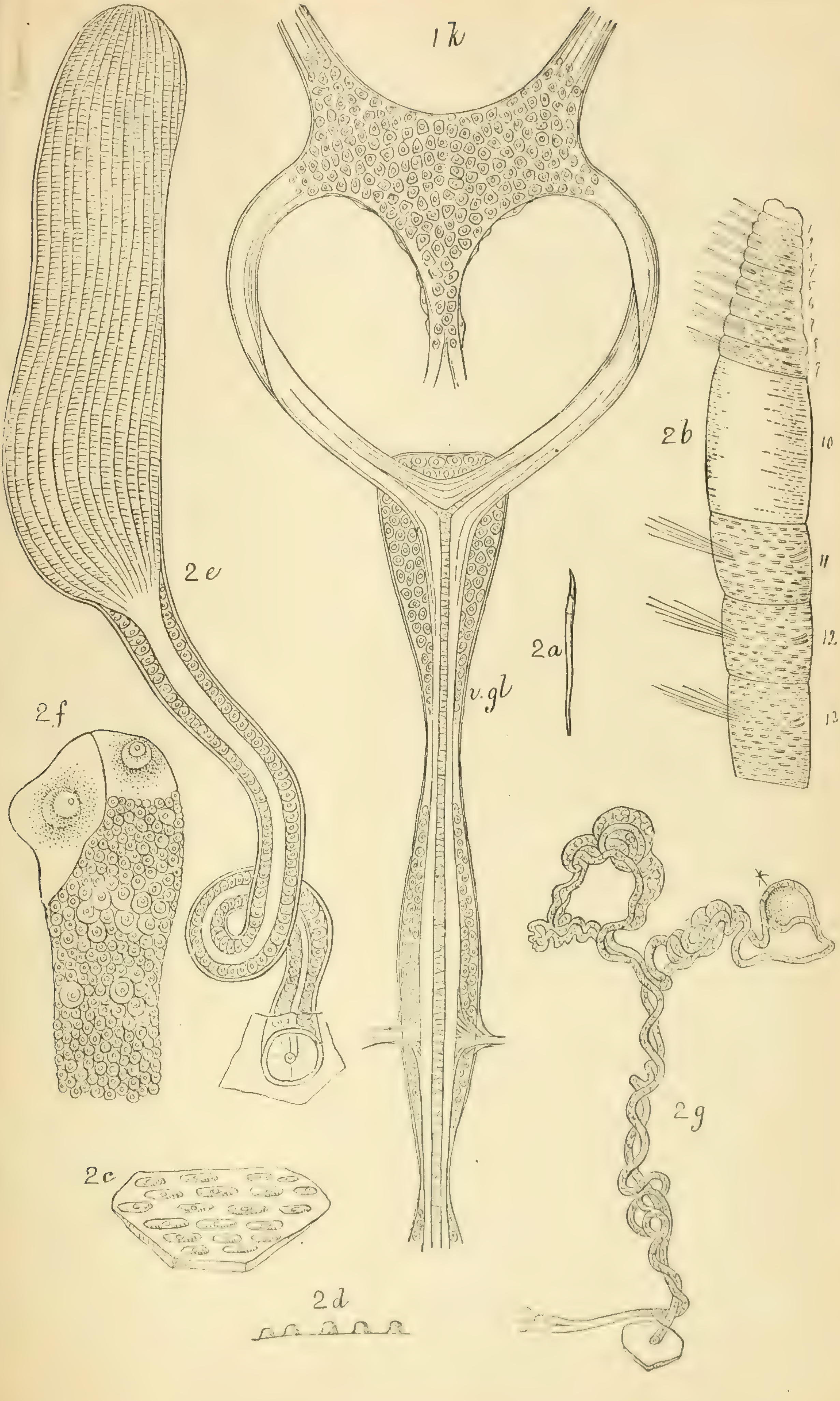
FIG. 1.—TELMATODRILUS VEJDOVSKYI.

Fig. 1 *k*.—The cephalic ganglion and the ventral nerve cord.

FIG. 2.—SPIROSPERMA FEROX.

Fig. 2 *a*.—The worm, natural size.
2 *b*.—The front part of the worm, highly magnified.
2 *c*.—A part of the epithelium, showing the elevated cells.
2 *d*.—The same, side view.
2 *e*.—One of the receptacles in the ninth setigerous segment.
2 *f*.—The free end of one of the ovaries.
2 *g*.—One of the segmental organs. At * is seen an enlarged chamber in the main duct.

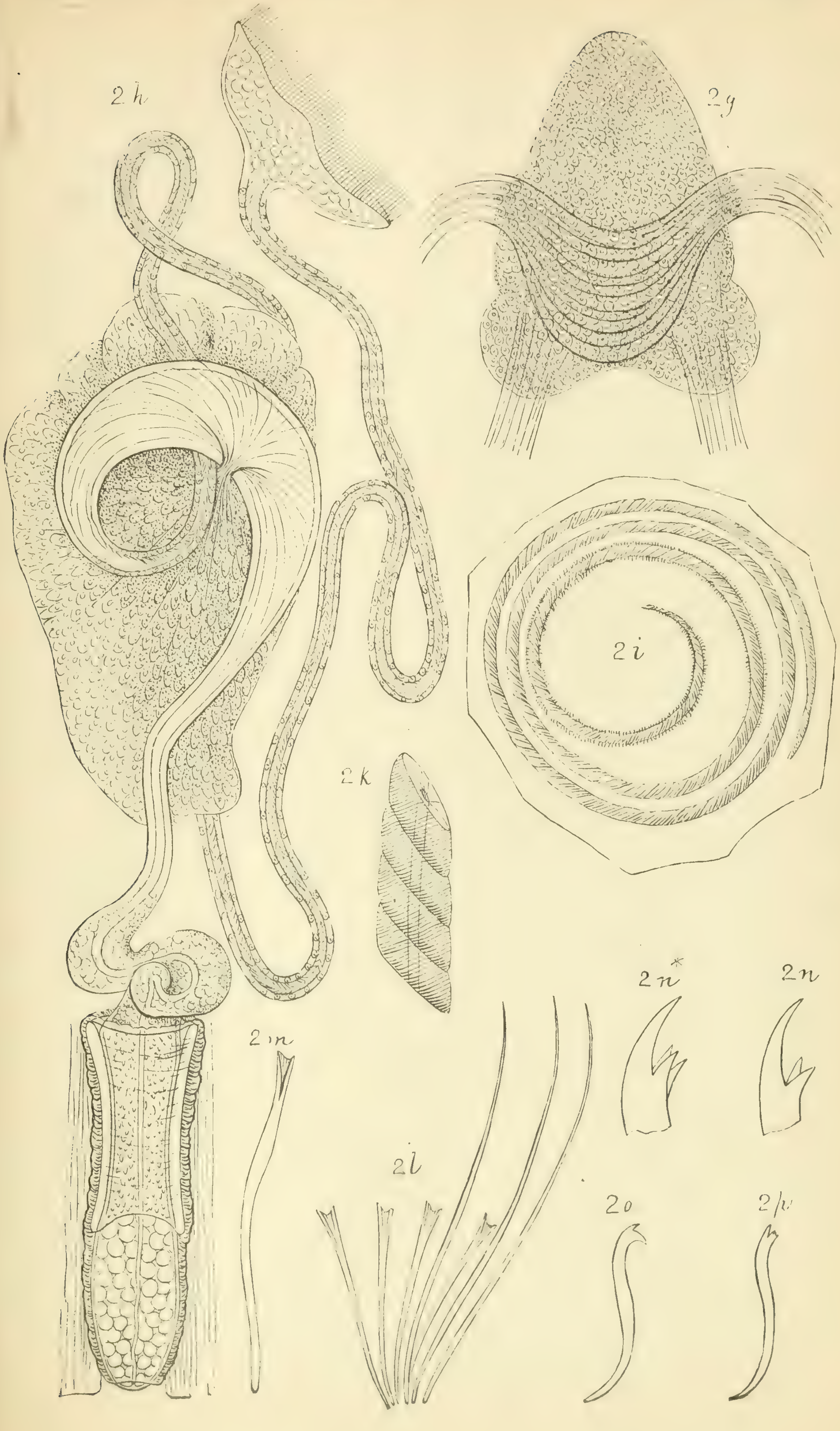
PLATE II.



EXPLANATION OF PLATE III.

FIG. 2.—SPIROSPERMA FEROX.

Fig. 2 *h.*—The efferent duct, atrium, prostata, penis, and oviduct.
2 *i.*—One of the spiral spermatophores, surrounded by a pellucid sack.
2 *k.*—A part of the same spermatophore, more highly magnified.
2 *l.*—A fascicle of spines from the upper side of the body.
2 *m.*—One of the fan-like spines from the above fascicle, highly magnified.
2 *n.*—The free end of a 3-forked spine.
2 *n.**—Free end of another spine with 4 prongs.
2 *o.*—One of the biforked spines, highly magnified.
2 *p.*—Another spine with 4 prongs. The spines with more than 2 prongs are from the cephalic segments.
2 *q.*—The cephalic ganglion, seen from above.

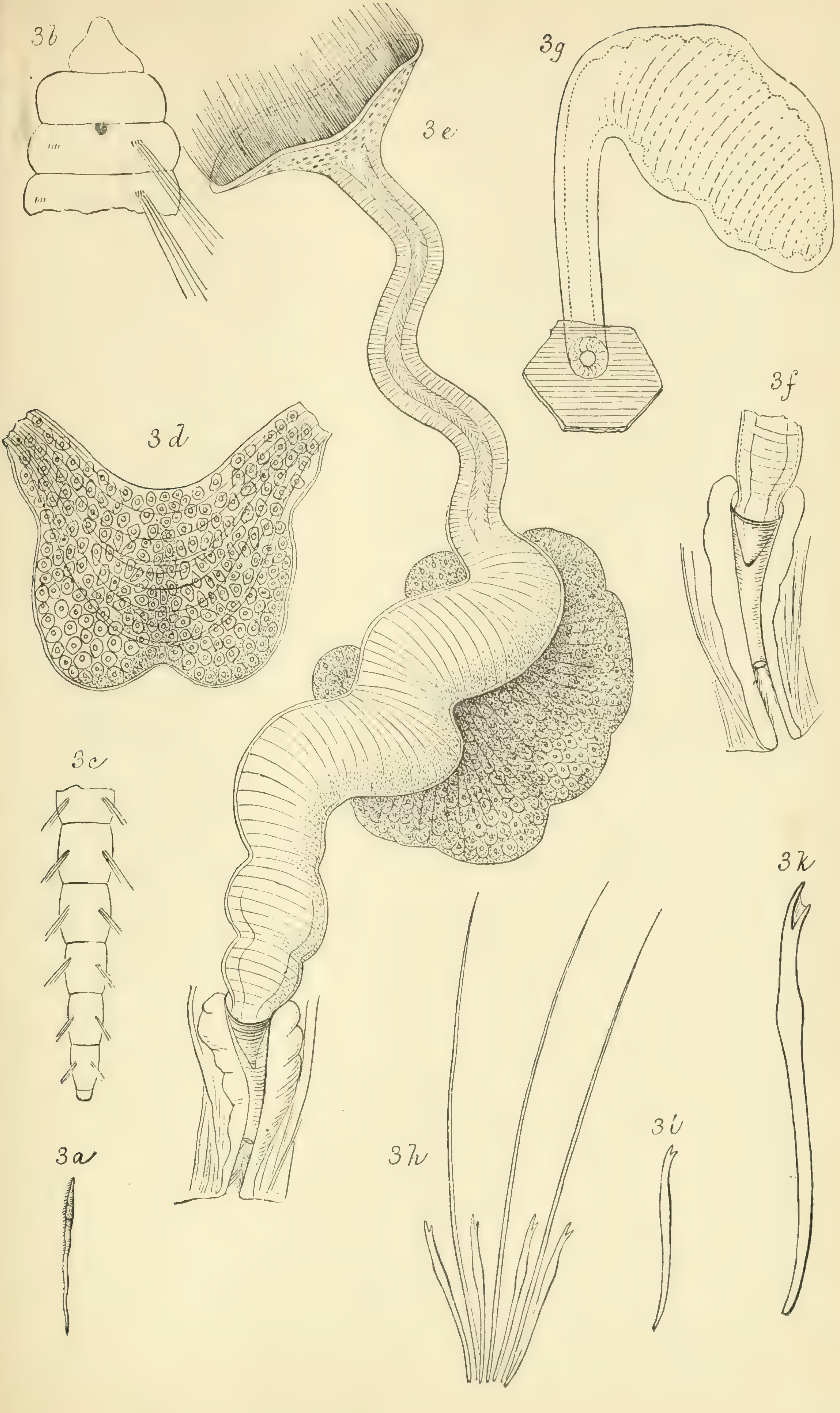

2 h
2 g
2 i
2 k
2 n*
2 n
2 m
2 l
2 o
2 p

EXPLANATION OF PLATE IV.

FIG. 3.—ILYODRILUS PERRIERII.

Fig. 3 *a.*—The worm, natural size.
3 *b.*—The front part of the worm, magnified.
3 *c.*—The hind part of the same.
3 *d.*—The cephalic ganglion.
3 *e.*—The efferent duct, atrium, penis, and oviducts.
3 *f.*—The penis and oviducts, more highly magnified.
3 *g.*—One of the receptacles.
3 *h.*—A fascicle of spines from the upper side of the body.
3 *i.*—One of the spines from the lower side of the body.
3 *k.*—One of the fan or comb like spines.

PLATE IV.



EXPLANATION OF PLATE V.

FIG. 4.—ILYODRILUS FRAGILIS.

Fig. 4 *a.*—The worm, natural size.

4 *b.*—The cephalic ganglion.

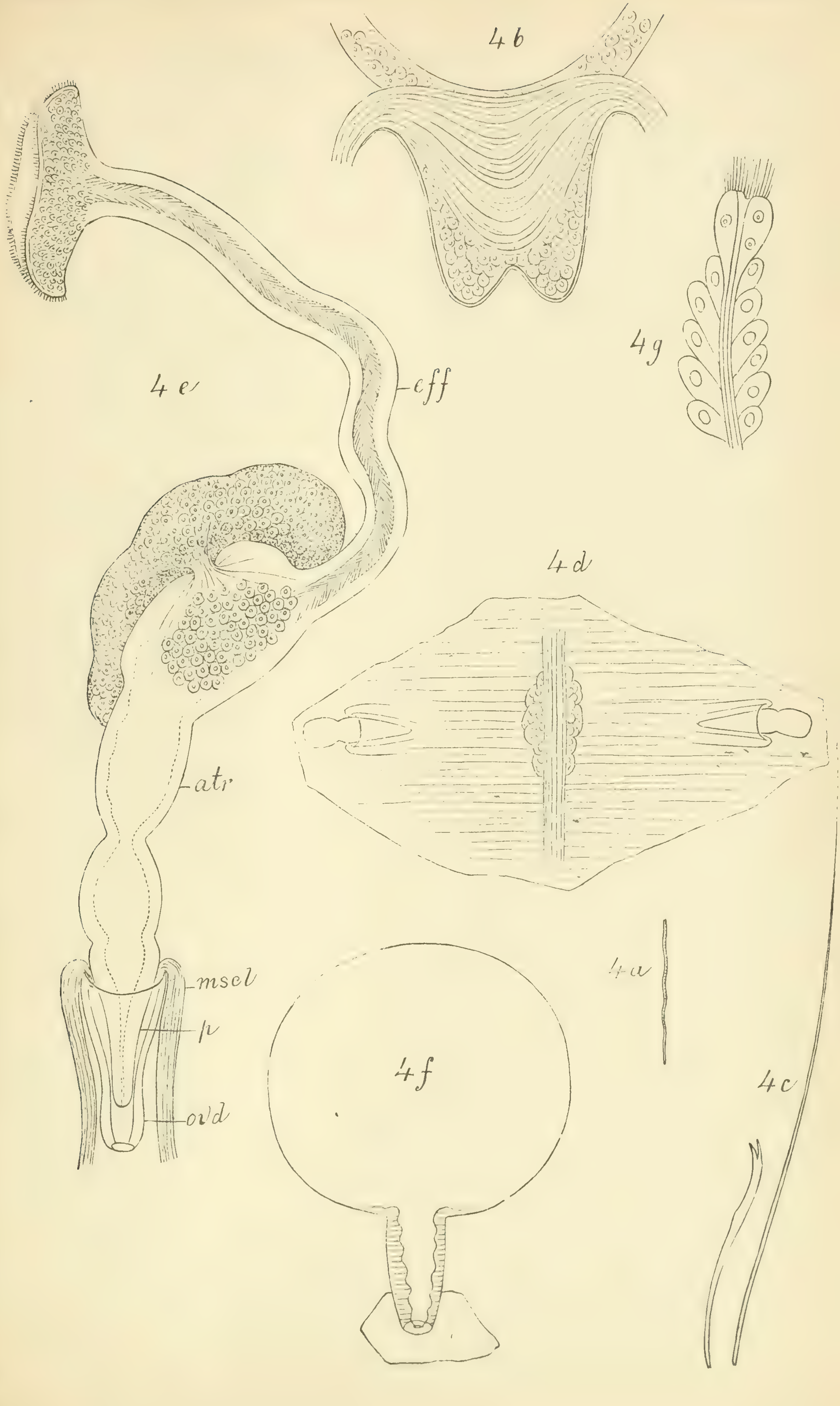
4 *c.*—One of the forked and one of the hair-spines.

4 *d.*—A part of the segment containing the efferent duct, showing the distance between the exterior opening of the penis and the ventral ganglion.

4 *e.*—Efferent duct, atrium, penis, and oviduct.

4 *f.*—One of the receptacles.

4 *g.*—The interior aperture of one of the segmental organs.

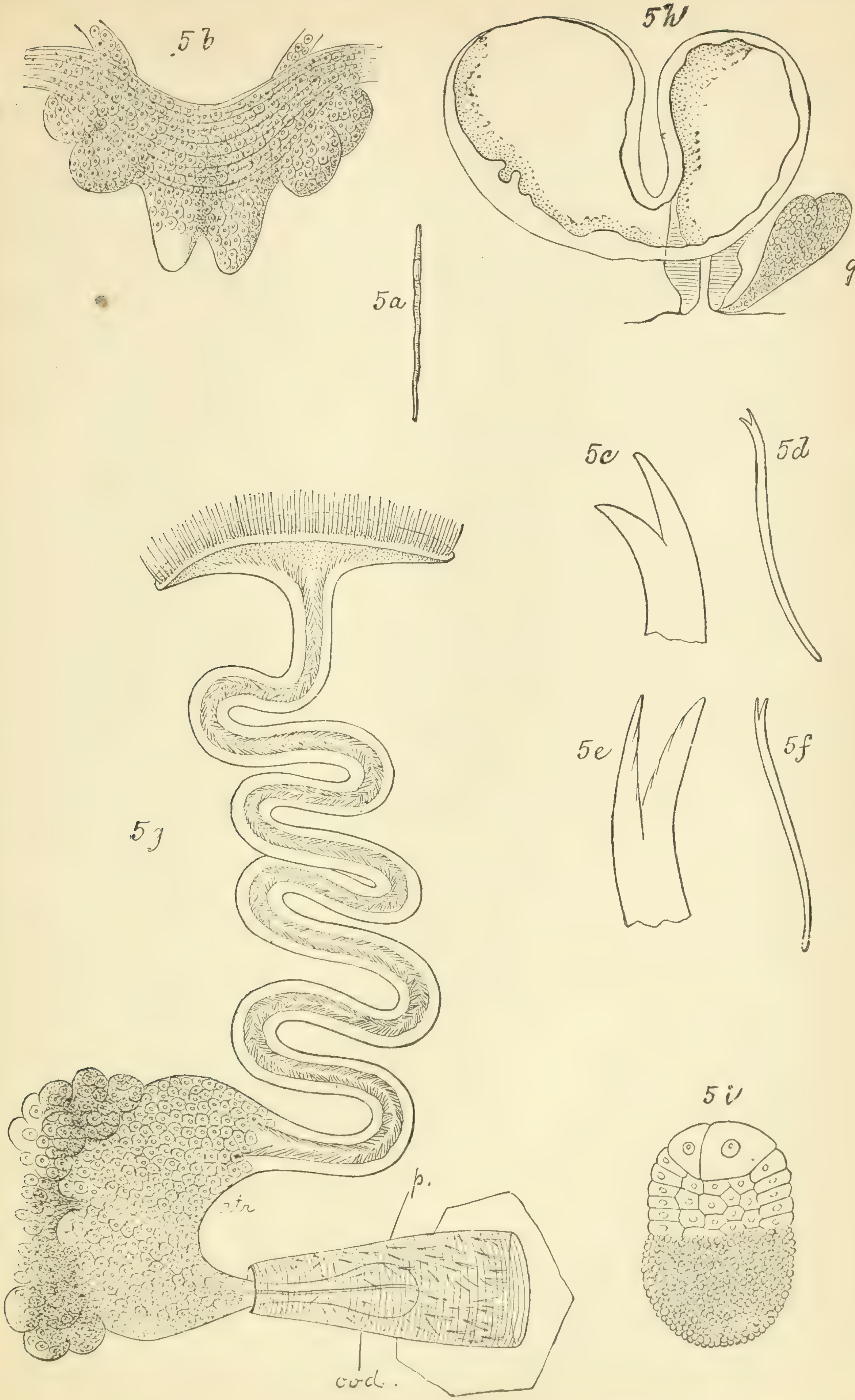

4 b
4 g
4 e
eff
4 d
atr
mscl
p
ovd
4 a
4 f
4 c

EXPLANATION OF PLATE VI.

FIG. 5.—ILYODRILUS SODALIS.

Fig. 5 *a.*—The worm, natural size.
5 *b.*—The cephalic ganglion.
5 *c.*—The front end of one of the forked spines.
5 *d.*—The same spine, whole.
5 *e.*—The front end of one of the spines, which occurs together with the hair-spines. It shows the beginning of a comblike structure.
5 *f.*—The same spine, whole.
5 *g.*—The efferent duct, atrium, prostata, penis, and oviduct. In the latter are seen numerous spicula.
5 *h.*—One of the receptacles. At its base is seen an accessory gland.
5 *i.*—One of the ovaries.

PLATE VI.



EXPLANATION OF PLATE VII.

FIG. 6.—HEMITUBIFEX INSIGNIS.

Fig. 6 *a*.—The worm, natural size.

6 *b*.—One of the spines.

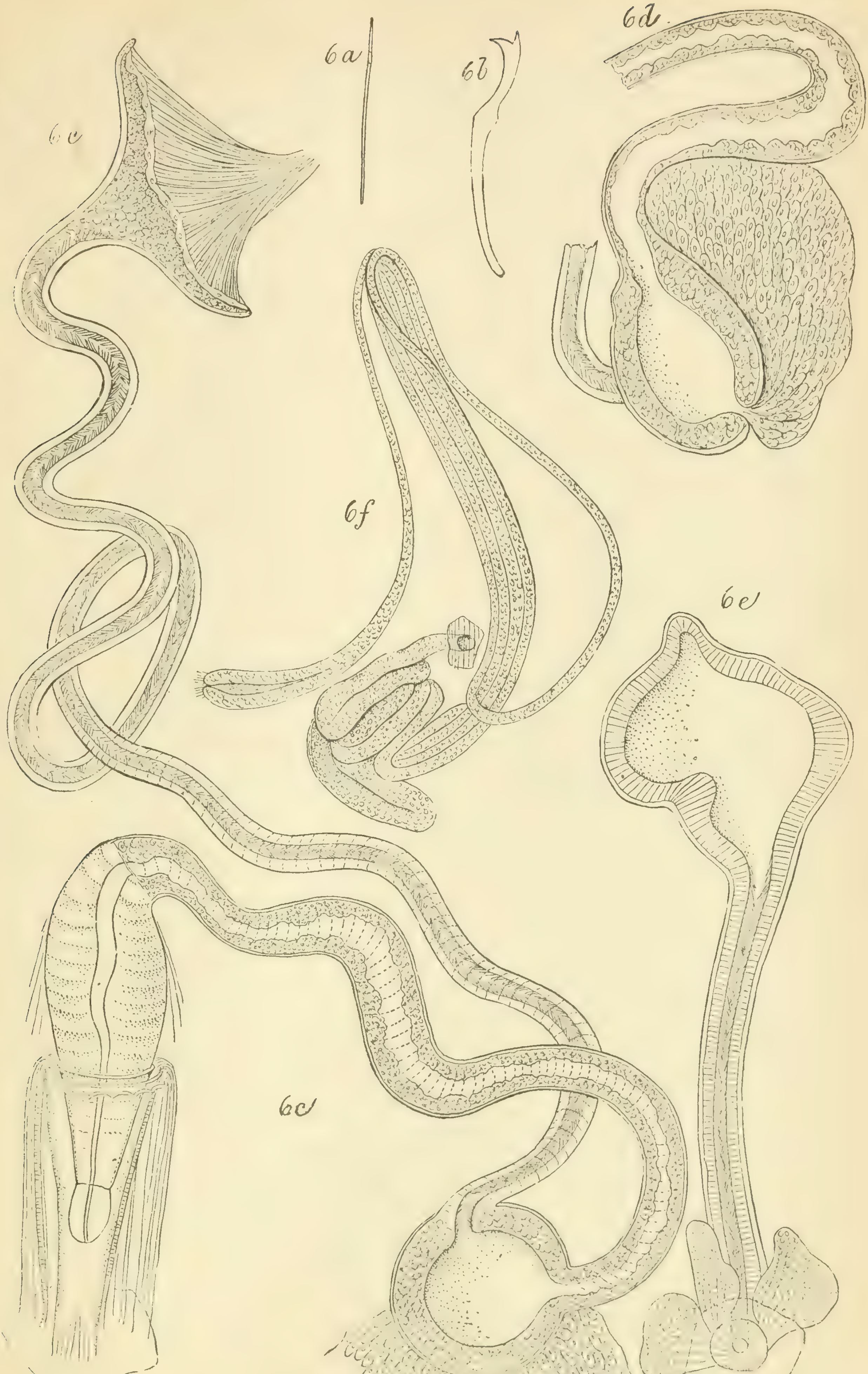
6 *c*.—The efferent duct, atrium, vesicula seminalis, prostata, penis, penis sheath, oviduct (exterior and interior). Numerous muscles are seen attached to the oviducts. *v. s* = vesicula seminalis.

6 *d*.—A part of the atrium, with the vesicula seminalis and the prostata gland.

6 *e*.—One of the receptacles. At its base are seen 3 winglike glands.

6 *f*.—One of the segmental organs.

PLATE VII.



EXPLANATION OF PLATE VIII.

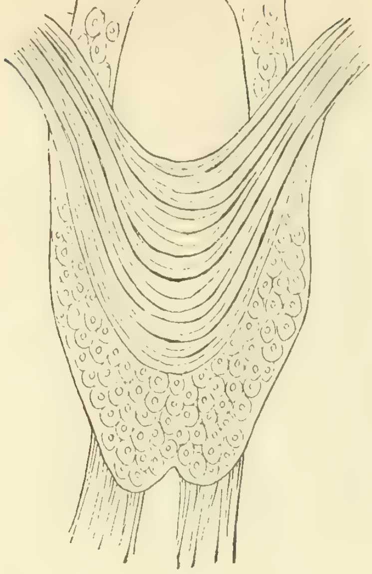
FIG. 6.—HEMITUBIFEX INSIGNIS.

Fig. 6 *g*.—The cephalic ganglion.
6 *h*.—One of the spermatophores.

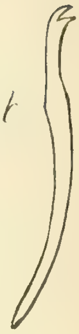
FIG. 7.—TUBIFEX CAMPANULATUS.

Fig. 7 *a*.—The cephalic ganglion.
7 *b*.—One of the spines.
7 *c*.—Efferent duct, atrium, prostata, penis, penis sheath, and oviducts.
7 *d*.—One of the receptacles.

7a



7b



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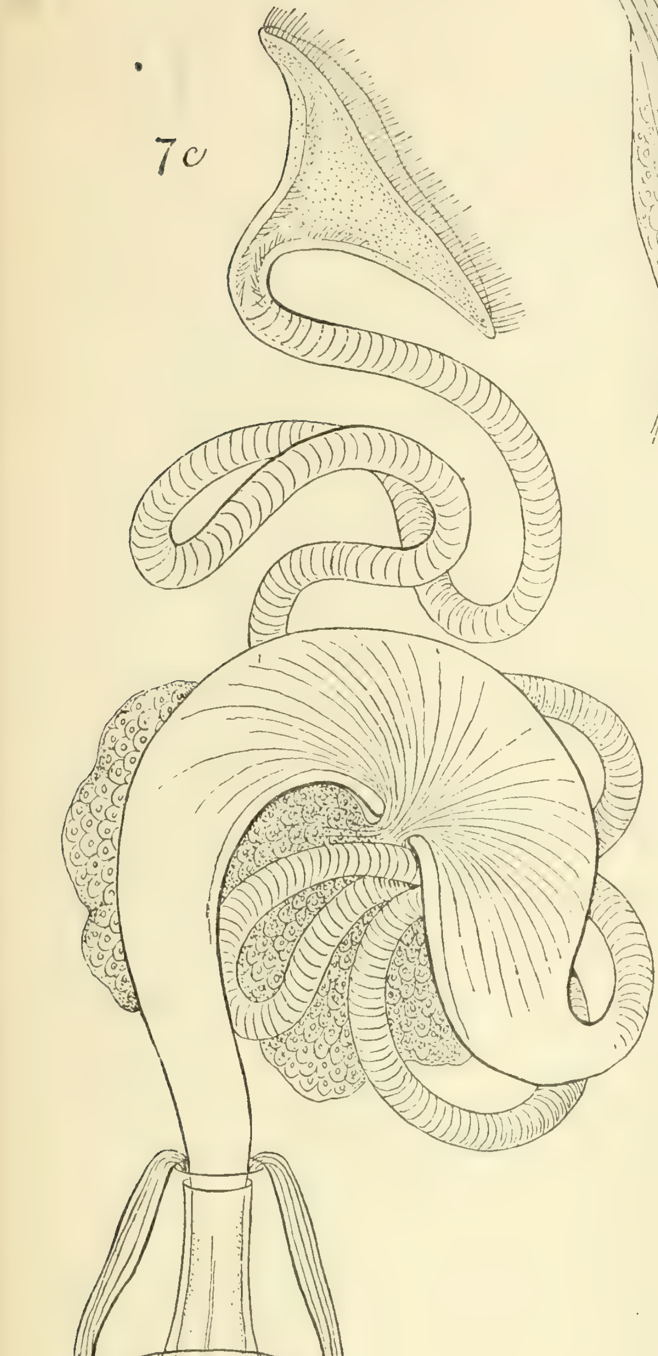
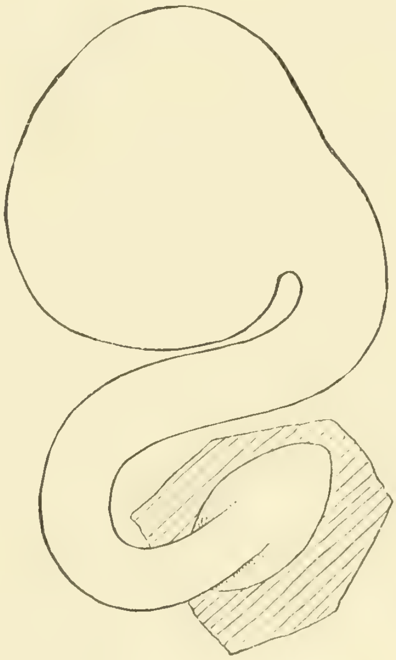
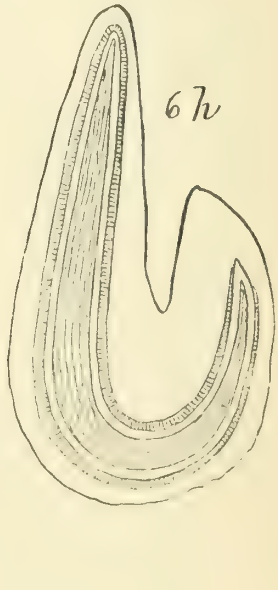


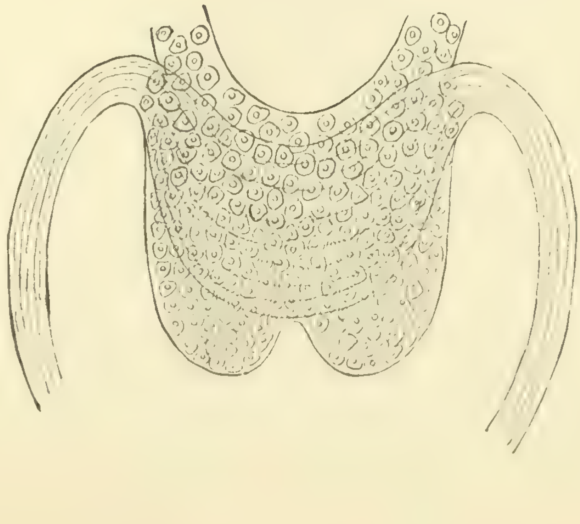
7d



6h



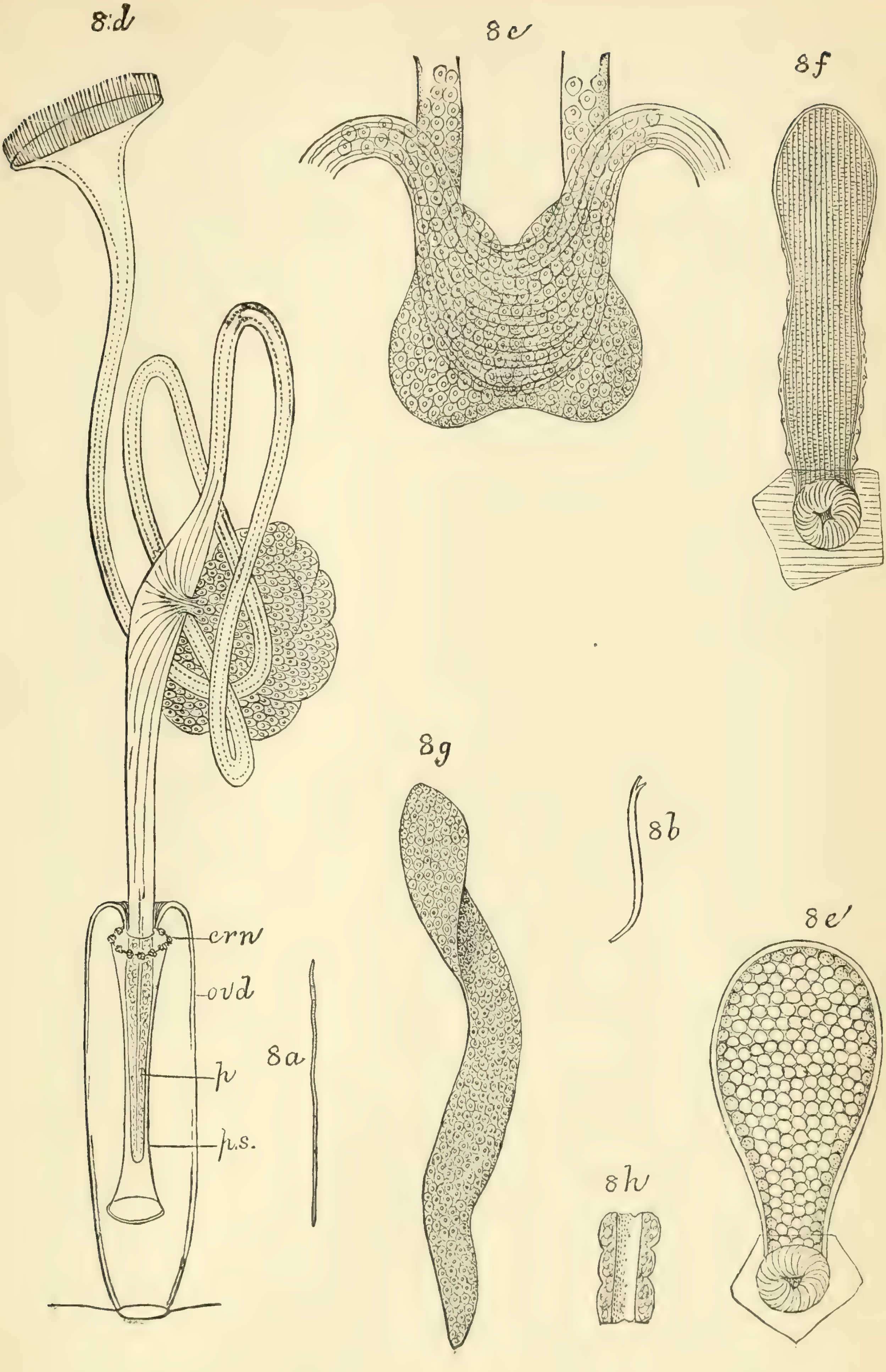
6g



EXPLANATION OF PLATE IX.

FIG. 8.—LIMNODRILUS ORNATUS.

Fig. 8 *a*.—The worm, natural size.
8 *b*.—One of the spines, magnified.
8 *c*.—The cephalic ganglion.
8 *d*.—Efferent duct, atrium, prostata, penis, penis sheath, and oviduct. Round the upper end of the penis sheath is seen a crown of starlike concretions.
8 *e*.—One of the receptacles.
8 *f*.—Another slightly modified receptacle, showing the striated surface.
8 *g*.—One of the ovaries.
8 *h*.—A part of the tube of the segmental organ.

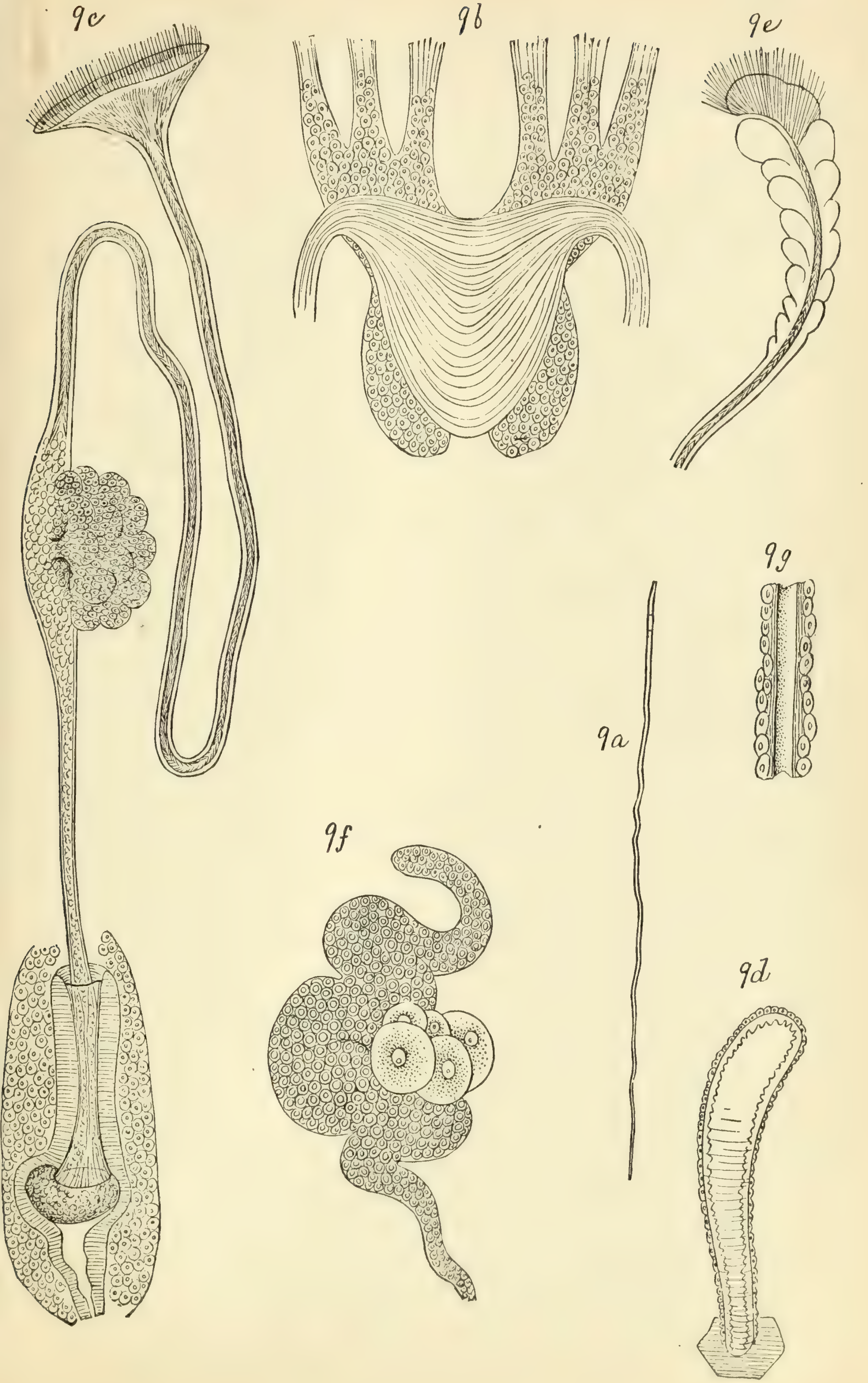

8 d
8 c
8 f
crn
ovd
p
p.s.
8 a
8 g
8 b
8 e
8 h

EXPLANATION OF PLATE X.

FIG. 9.—LIMNODRILUS STEIGERWALDII.

Fig. 9 *a.*—The worm, natural size.
9 *b.*—The cephalic ganglion, seen from below.
9 *c.*—Efferent duct, atrium, prostata, penis, penis sheath, interior and exterior oviduct.
9 *d.*—One of the receptacles.
9 *e.*—The interior aperture of a segmental organ, highly magnified.
9 *f.*—One of the ovaries.
9 *g.*—A part of the tube of a segmental organ.

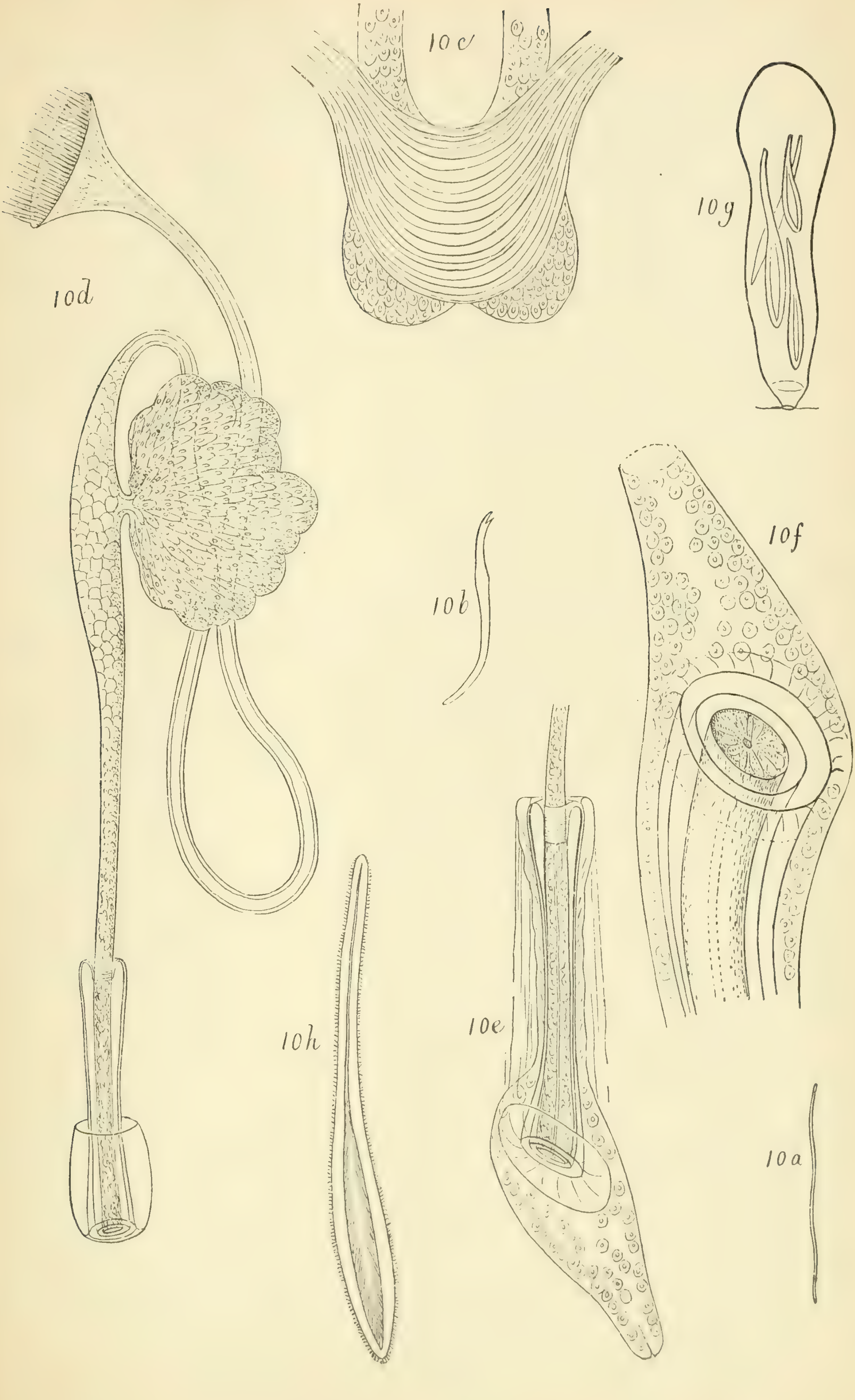
PLATE X.



EXPLANATION OF PLATE XI.

FIG. 10.—LIMNODRILUS MONTICOLA.

Fig. 10 *a.*—The worm, natural size.
10 *b.*—One of the spines.
10 *c.*—The cephalic ganglion.
10 *d.*—Efferent duct, atrium, penis, penis sheath, oviducts (interior and exterior).
10 *e.*—Penis and oviducts, more highly magnified.
10 *f.*—The exterior end of the penis, penis sheath, and oviducts.
10 *g.*—One of the receptacles, with spermatophores.
10 *h.*—One of the spermatophores, highly magnified.


10c
10g
10d
10b
10f
10e
10h
10a

EXPLANATION OF PLATE XII.

FIG. 11.—LIMNODRILUS ALPESTRIS.

Fig. 11 *a.*—The front part of the nervous system, showing the (sometimes) 3-lobed cephalic ganglion, seen from above.

11 *b.*—Efferent duct, atrium, prostata, penis, penis sheath, and the two oviducts.

11 *c.*—Atrium and upper part of the copulative organs; common form.

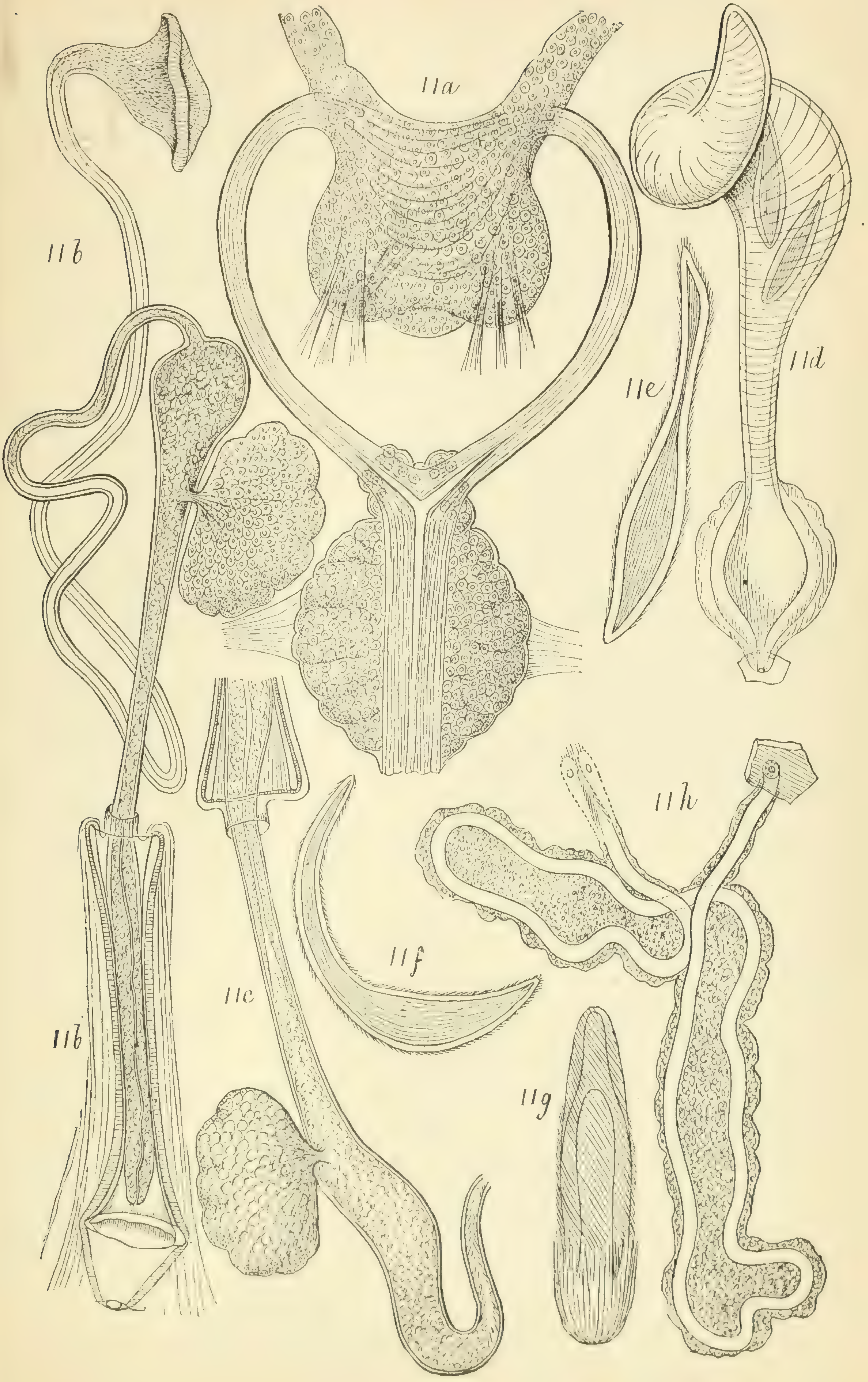
11 *d.*—One of the receptacles.

11 *e.*—Spermatophore.

11 *f.*—Spermatophore.

11 *g.*—Spermatophore.

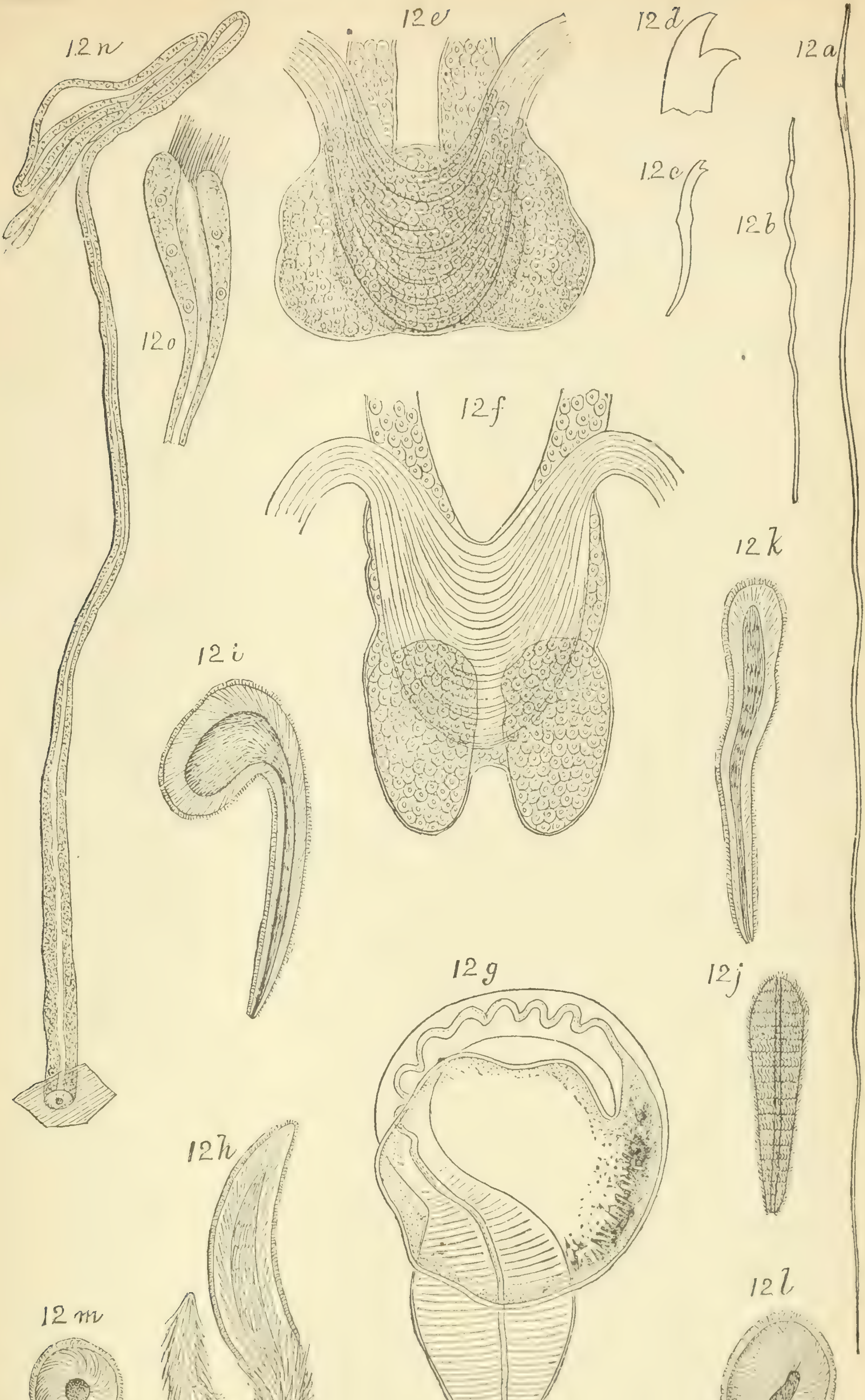
11 *h.*—One of the segmental organs.


11a
11b
11e
11d
11b
11c
11f
11h
11g

EXPLANATION OF PLATE XIII.

FIG. 12.—LIMNODRILUS SILVANI.

Fig. 12 *a.*—The worm, large form, natural size.
12 *b.*—The worm, smaller form, natural size.
12 *c.*—One of the spines.
12 *d.*—The front part of the same spine.
12 *e.*—Cephalic ganglion, broadest form.
12 *f.*—Cephalic ganglion, longest form.
12 *g.*—One of the receptacles.
12 *h.*—Spermatophore.
12 *i.*—Spermatophore.
12 *j.*—Spermatophore.
12 *k.*—Spermatophore.
12 *l.*—Spermatophore.
12 *m.*—Spermatophore.
12 *n.*—One of the segmental organs.
12 *o.*—The interior aperture of the same organ.


12 n
12 e
12 d
12 a
12 o
12 c
12 b
12 f
12 k
12 i
12 g
12 j
12 h
12 m
12 l

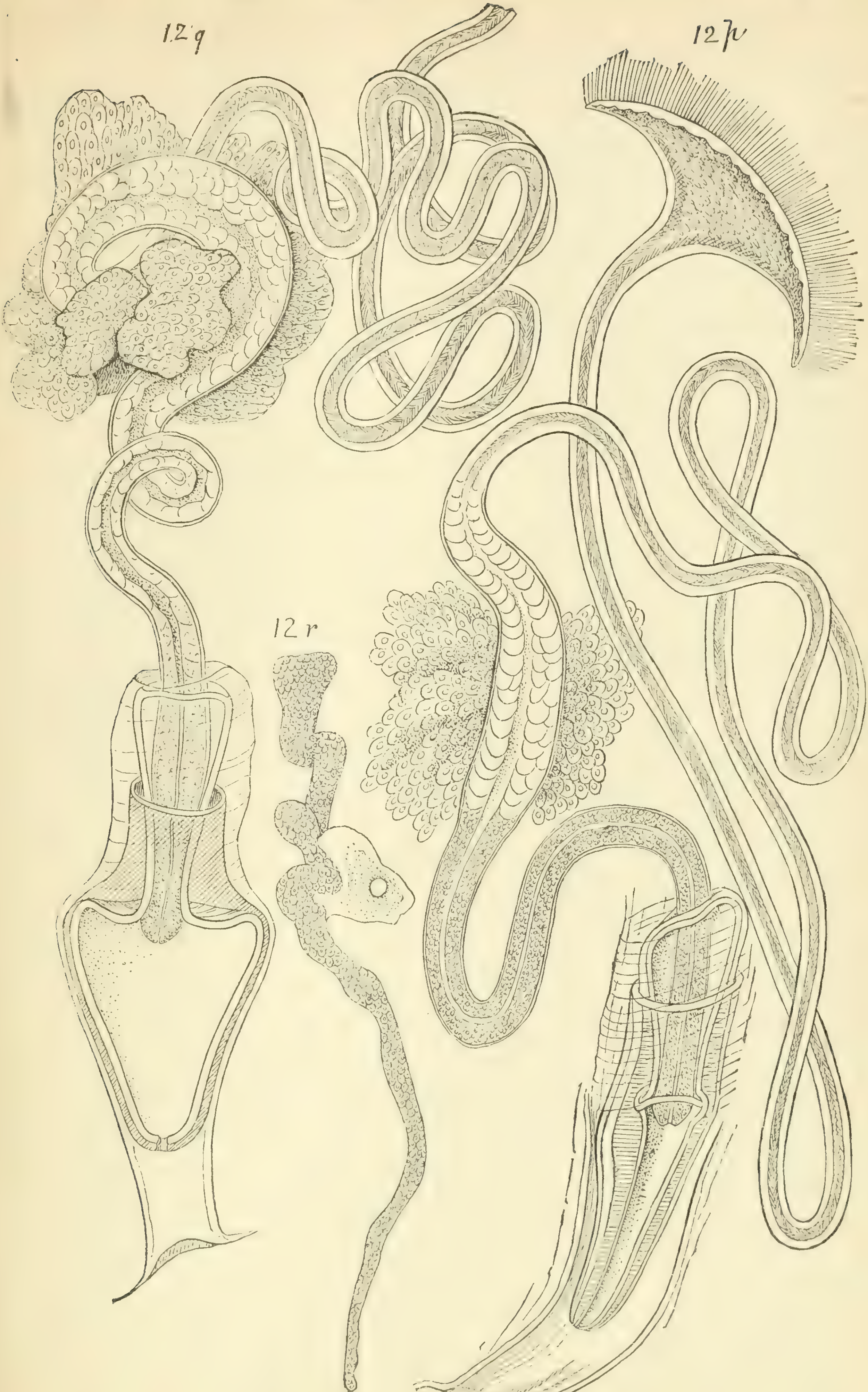
EXPLANATION OF PLATE XIV.

FIG. 12.—LIMNODRILUS SILVANI.

Fig. 12 *p*.—Efferent duct, atrium, penis, penis sheath, interior and exterior oviducts. The organ is seen from the side.

12 *q*.—The same organ, seen from the front.

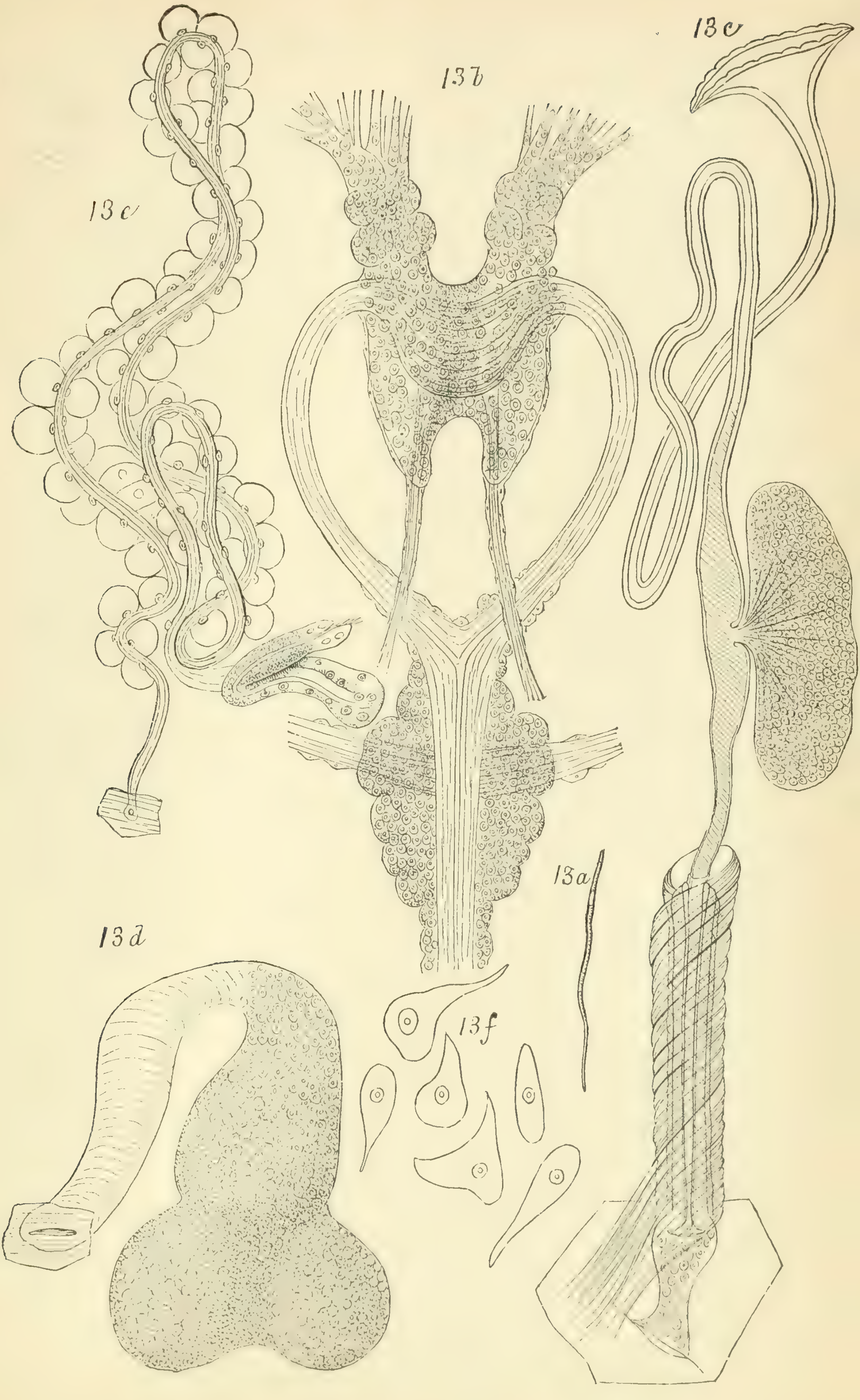
12 *r*.—One of the ovaries.


12 q
12 p
12 r

EXPLANATION OF PLATE XV.

FIG. 13.—CAMPTODRILUS IGNEUS.

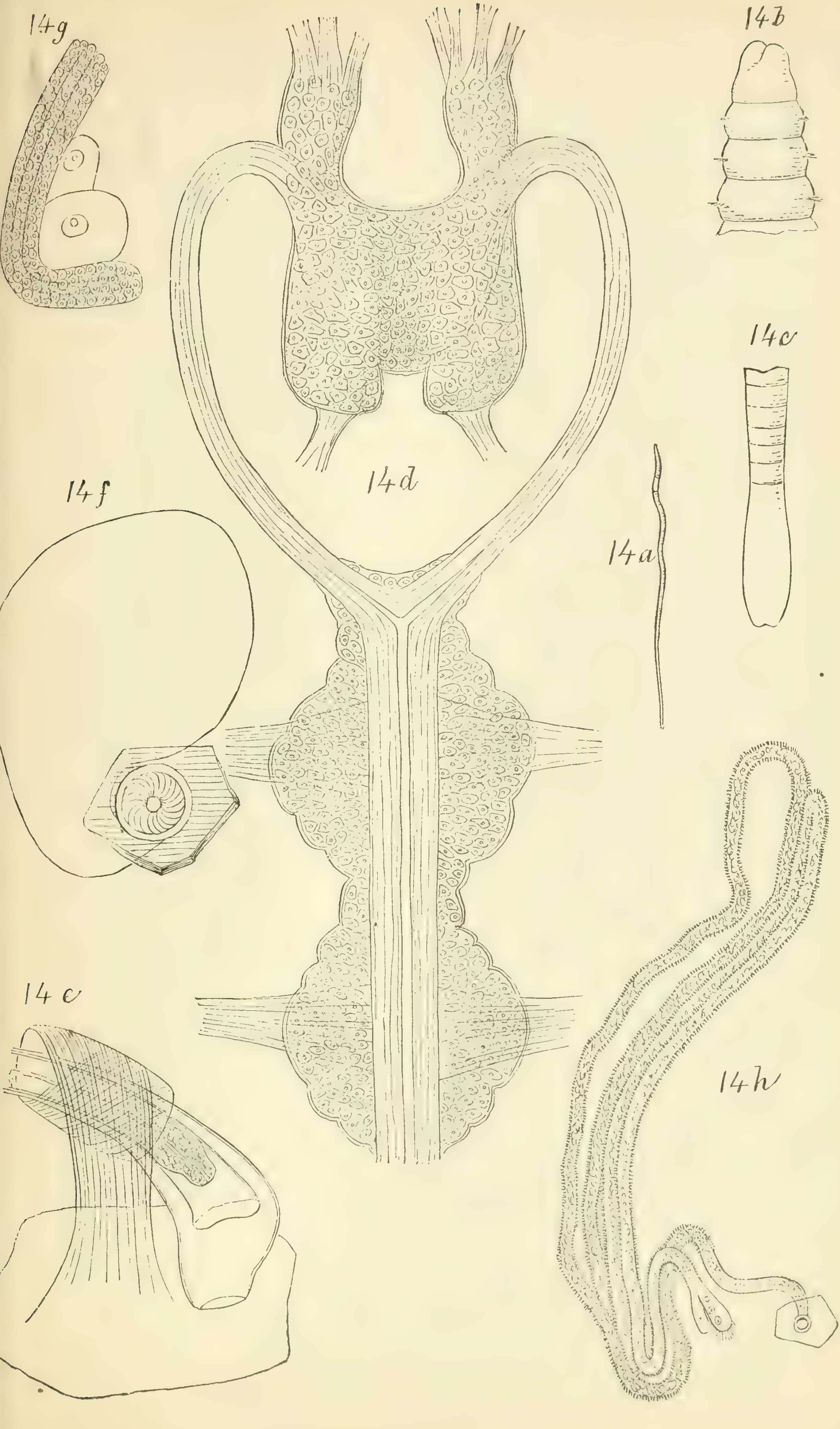
Fig. 13 *a*.—The worm, natural size.
13 *b*.—The front part of the nervous system, seen from above.
13 *c*.—Efferent duct, atrium, prostata, penis, penis sheath, oviduct, and spiral muscles.
13 *d*.—One of the receptacles.
13 *e*.—One of the segmental organs.
13 *f*.—Perigastric cells, of different form.


13c
13b
13e
13a
13d
13f

EXPLANATION OF PLATE XVI.

FIG. 14.—CAMPTODRILUS CORALLINUS.

Fig. 14 *a.*—The worm, natural size.
14 *b.*—Front part of the worm, magnified.
14 *c.*—Posterior part of the worm, magnified.
14 *d.*—Front part of the nervous system, seen from above.
14 *e.*—The lower part of the copulative organs, showing part of penis, penis sheath, oviduct, and spiral muscles.
14 *f.*—One of the receptacles.
14 *g.*—One of the ovaries.
14 *h.*—One of the segmental organs.


14g
14b
14c
14d
14f
14a
14e
14h

EXPLANATION OF PLATE XVII.

FIG. 11.—LIMNODRILUS ALPESTRIS.

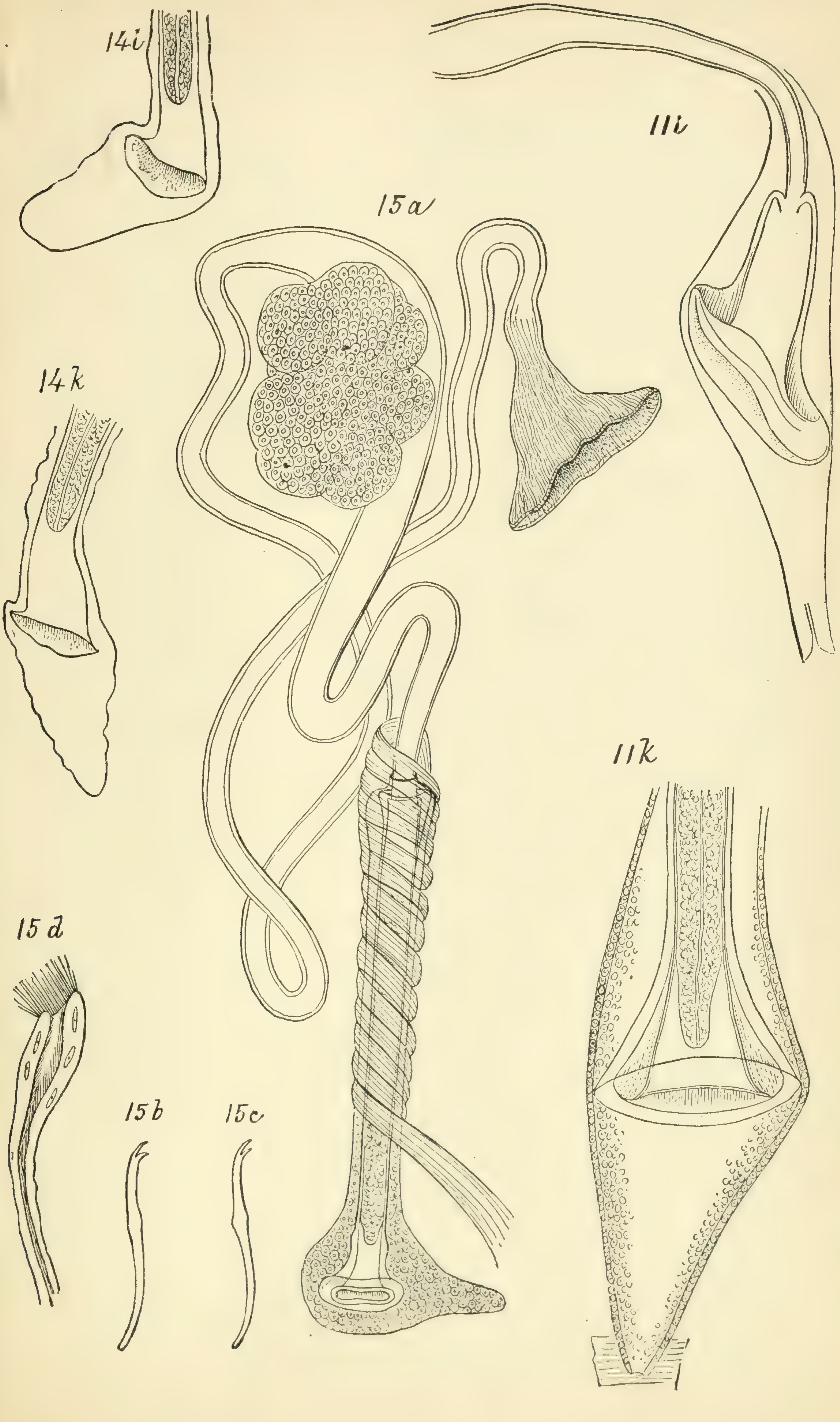
Fig. 11 *i*.—The copulative organs in a very young specimen.
11 *k*.—The same organ in a more advanced individual.

FIG. 14.—CAMPTODRILUS CORALLINUS.

Fig. 14 *i*.—The lower end of the copulative organs, showing the penis, penis sheath, and oviduct.
14 *k*.—The same as above, from another individual.

FIG. 15.—CAMPTODRILUS SPIRALIS.

Fig. 15 *a*.—The efferent duct and funnel, atrium, prostata, penis, penis sheath, exterior and interior oviducts, and spiral muscles.
15 *b*.—One of the spines from behind the cingulum.
15 *c*.—One of the spines from one of the anterior segments.
15 *d*.—The front part of the interior aperture of a segmental organ.

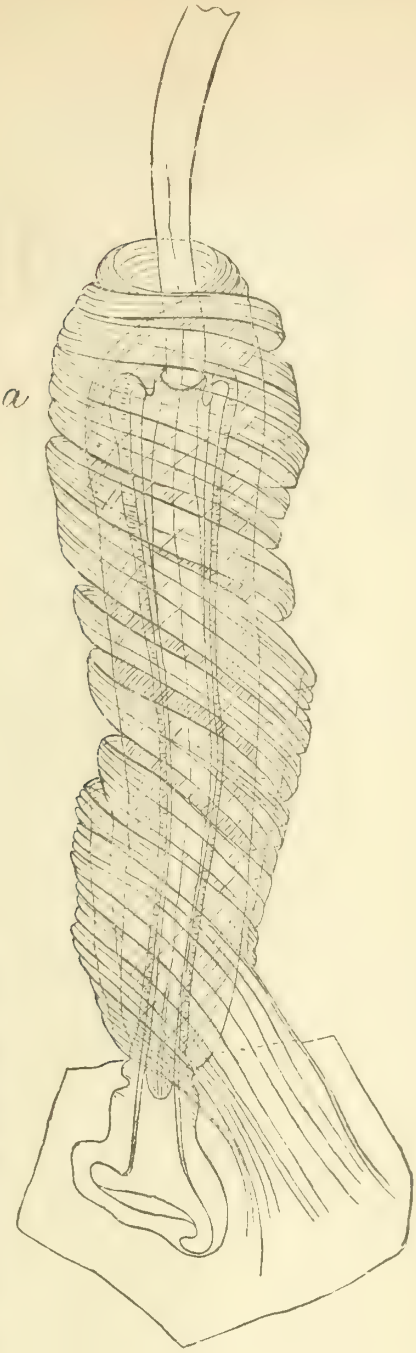

14i
11i
15a
14k
11k
15d
15b
15c

EXPLANATION OF PLATE XVIII.

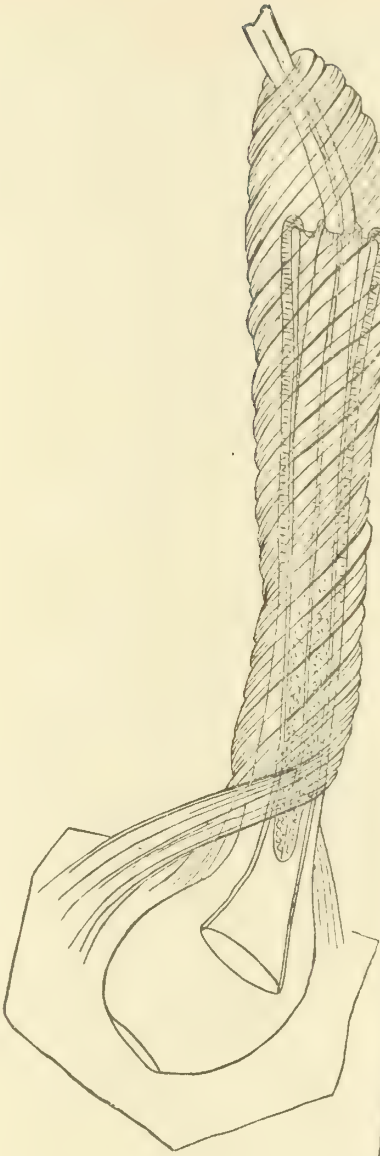
Fig. 13 *g.*—*Camptodrilus igneus.*
14 *b.*—*Camptodrilus corallinus.*
16 *a.*—*Camptodrilus Californicus.*
16 *b.*—*Camptodrilus Californicus.*

All the figures represent the lower end of the copulative organs.

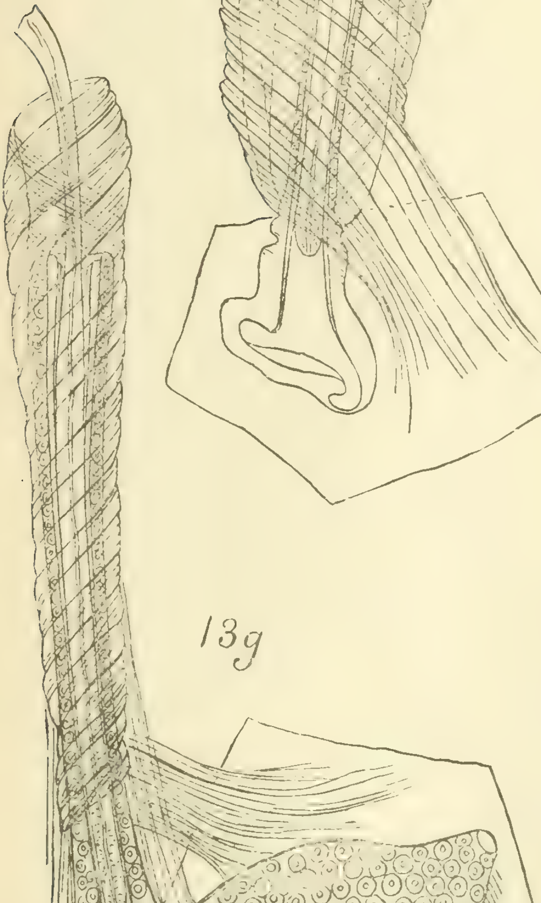
PLATE XVIII.



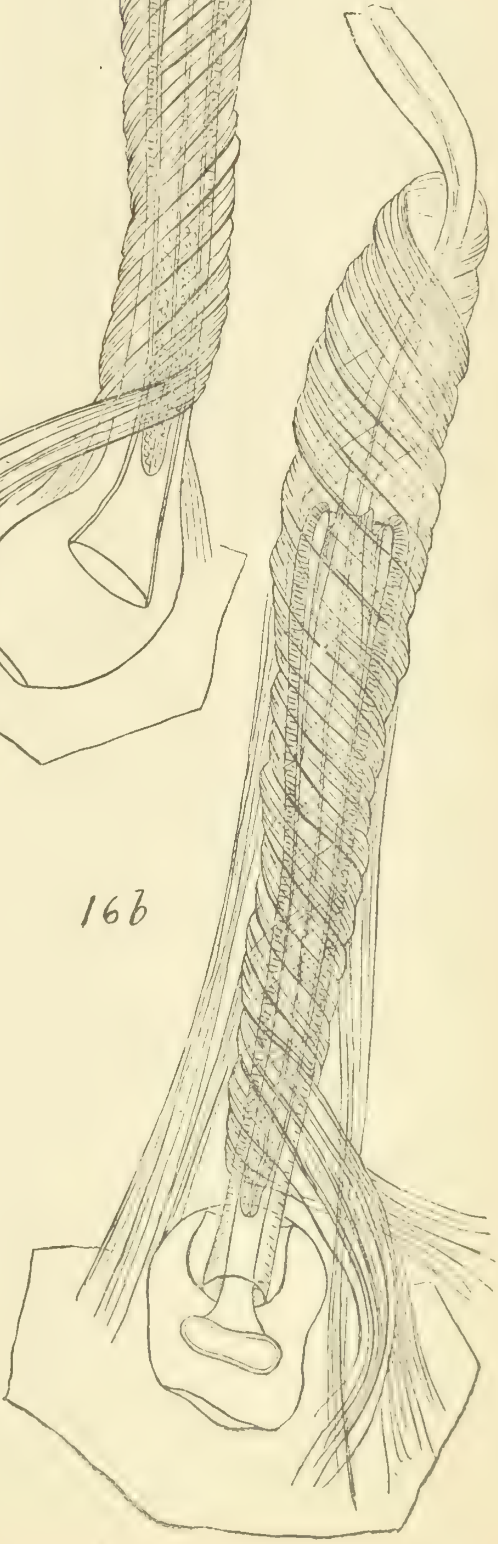
16 a



14 b



13 g



16 b

EXPLANATION OF PLATE XIX.

FIG. 17.—TELMATODRILUS VEJDOVSKYI.

Fig. 17 *a*.—A part of the copulative organ of a young individual. The oviduct (=ovd.) is not yet fully differentiated, but is seen entirely inclosing penis, atrium, and prostata glands.

17 *b*.—The same as above, in a fully developed individual.

FIG. 18.—LIMNODRILUS ALPESTRIS.

All the figures represent the copulative organs, demonstrating their mode of development from the original generative gland to the fully developed form of the adult individual.

Fig. 18 *a*.—The generative gland as it is first seen on the body wall of the tenth setigerous segment, seen from above.

18 *b*.—The same as above, side view, and somewhat more magnified.

18 *c*.—The same gland, but in a more advanced state of development. The cortical layer is well separated from the interior matrix. In the latter is seen the lumen of the penis. (This figure is from *L. corallinus*.)

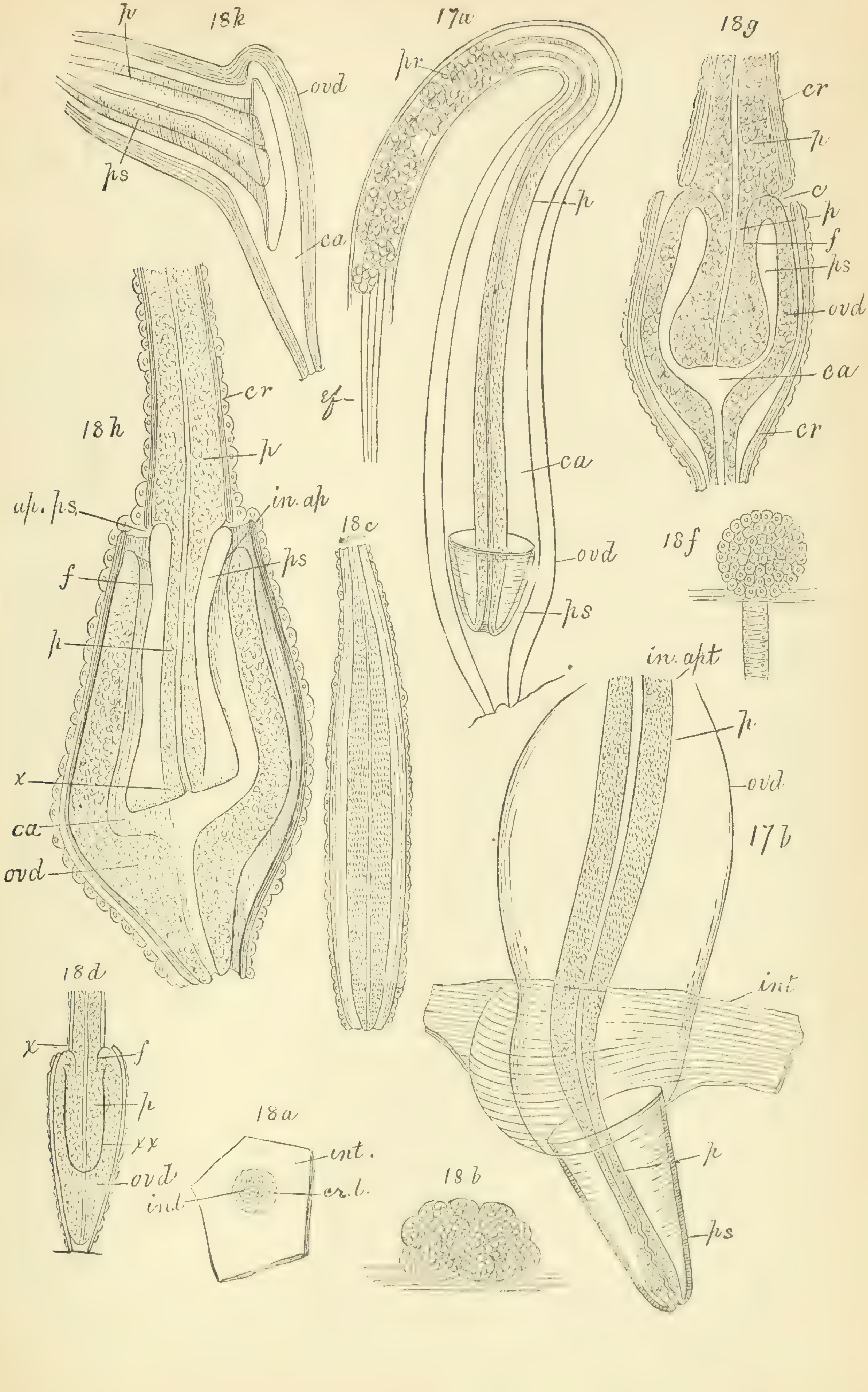
18 *d*.—The same as above, in a yet more advanced state of development. In the interior of the matrix is seen a semi-elliptic line (*x x*) separating the future penis (*p.*) from the oviduct proper (*ovd.*). At *x* is seen the first sign of the aperture of the penis sheath. (This figure is from *L. alpestris.*)

18 *f*.—The first beginning of the efferent funnel. The aperture is not yet differentiated.

18 *g*.—The same as 18 *d*, but in a more advanced stage of development. The cavity (*ca.*) between the oviduct and penis sheath is further developed, but the oviduct (*ovd.*) is not yet fully separated from the penis and penis sheath, the connection being at *c*. The cavity between the penis and the penis sheath is enlarging. The cortical layer (*cr.*) forms an exterior oviduct and is separated by a cavity from the interior sheath of the oviduct (*ovd.*).

18 *h*.—The same as above, in a more advanced stage of development. The interior oviduct is fully separated from the penis sheath (*p. s.*), and the aperture (*in. ap.*) is defined. The penis sheath (*p. s.*) is also nearly fully separated from the penis, but connects as yet at *x*. The oviduct (*ovd.*) and the cortical layer are fully separated, but the former is yet connected with the sexual porus. The aperture of the penis sheath is well defined (*ap. p. s.*).

18 *k*.—The lower end of a perfectly developed copulative organ of a *Limnodrilus*, with a single oviduct. The penis sheath is fully separated from the penis proper.


18k
pv
ovd
ps
ca
17a
pr
p
ef
ca
ovd
ps
18g
cr
p
c
p
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ps
ovd
ca
cr
18h
cr
pv
ap. ps.
in. ap
f
ps
p
x
ca
ovd
18c
18f
in. apt
p
ovd
17b
int
p
ps
18d
x
f
p
xx
ovd
18a
int.
cr. l.
int
18b

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XXI.—THE AQUA-VIVARIUM AS AN AID TO BIOLOGICAL RESEARCH.

By William P. Seal.

The somewhat obsolete term "aqua-vivarium" is used in this article because it expresses shades of meaning not covered by any other word or term known to the writer. It is comprehensive, describing the establishment of methods, approximating to natural conditions, for the study of the varied forms of life which wholly or in part inhabit the waters. The word "aquarium" is properly restricted to a harmonious adjustment of the relations between animal and vegetable life wholly aquatic, while the term "aqua-vivarium" applies to this and also to receptacles arranged as homes for amphibious animals.

While rapid advance has been made in the methods of the study of life, while biological laboratories splendidly equipped with scientific appliances are rapidly becoming prominent features of our leading universities, but little attention has been paid to the establishment of means whereby the life histories of the lower forms of life may be studied in continuity. Apart from the embryological researches of the U. S. Fish Commission, through its embryologist, Mr. John A. Ryder, which are confined principally to a study of food-fishes; and the private biological laboratories of Professors Agassiz and Brooks, on the Atlantic coast, there seems to be no effort in this direction. The desirability of the establishment of practical propagating adjuncts to biological laboratories is universally acknowledged. No doubt the history of the great public aquariums of Europe, with their enormous expenditure of money and manifest lack of adequate scientific results, has much to do with the general apathy on this subject. It is not, however, by the expenditure of large sums of money that the ideal adjunct to the biological laboratory will be established. In fact, with the expensive and highly artificial methods in vogue better results than have been attained are not to be expected.

It is the desire of the writer to show how, at comparatively small expense, conditions which closely approximate those of nature, and afford the most gratifying results, may be established, under which conditions the lower forms of life will live contentedly, generate, and always be accessible to the investigator.

The grand requisite is that animals shall be furnished with places suited to their various requirements—light, temperature, and food be-

ing primary considerations. Any attempt at biological investigation which disregards the special requirements and natural habits of the forms of life under investigation must result in disappointment. A curious instance in illustration of this point is quoted from The Family Aquarium, written by Butler:

"There are plants, too, which will not thrive in tranquil waters. Sir John Paxton, knighted for his successful conception of the plan of erecting the novel building so renowned and imitated as the Crystal Palace, discovered this fact when he was a simple florist to the Duke of Devonshire. A gigantic South American water-lily, brought from the river Amazon, and well known at the present time as the *Victoria regia*, refused to flower under his care in the elegant tank he had prepared for it. Suspecting at length that the want of motion in the water might have something to do with its contumacy, he arranged a little paddle-wheel in such a manner that a mimic stream should roll over it, and thus in its fall into the tank continually agitate its contents. The ruse was successful. The lily imagined itself once more at home, and being perfectly at its ease expanded its giant flowers without further reluctance or solicitation."

The aquarium tank, while being indispensable for purposes of close observation in special cases of interest, is by reason of its great artificialty (that is, unnatural light, and injurious temperature in warm weather through exposure to the atmosphere on all sides), generally unfit for the generative development of fish, reptiles, crustaceans, &c., although they may be kept alive in such tanks for long periods. But for the purpose of close observation, such animals when at the proper stage of development, may be safely transferred to aquariums for short periods.

The necessity of imitating nature being kept in view, it is evident that the work is to be begun in the open air or outside of ordinary closed buildings, in order that there may be an abundance of light.

First, then, a piece of ground is needed proportioned to the magnitude of the operations. The proposed aqua-vivaria are simply excavations (trenches or basins) in the earth, of any desired size or shape. The excavations are to be lined with Portland cement to the thickness of a half inch or more, the cement being simply plastered against the earth walls without other backing. By excavating to but half the desired depth and banking up the removed earth around the outer edges of the basin, the aqua-vivaria will be raised above the reach of sudden and heavy rainfalls. They will be much strengthened by sodding the outside, though this is not necessary where they are permanently inclosed after the manner of hot-beds. It will be necessary that they be so inclosed during the winter months, and in some way heated during the prevalence of extremely cold weather. A small amount of heat will prevent the freezing of water under glass; and it may be done simply and inexpensively, after the manner of greenhouse heating.

Aside from the question of economy and the advantages gained in light and temperature, the capability of change or modification at trifling labor and expense, as experience may suggest, will prove a source of great satisfaction. While closely approximating natural conditions, the advantages gained over the conditions of nature are like those of a cultivated garden, in which everything is clean and orderly, over an uncultivated field.

Plate I represents the simplest and least expensive form of the aqua-vivaria here suggested, with section of front cut away to show the interior. There are many ways in which the interior may be arranged, affording equally satisfactory results. In fact, we may follow our individual fancy in this respect, so that we avoid artificiality as much as possible. The following suggestions, however, may be useful to some. The bottom may be made uniform and a bed of three or four inches of sand placed over it in which to root the plants which may be introduced ; or it may be made of varying depths with hollows at intervals in which to put the sand and plants. Another and very satisfactory method is to root the plants in large dishes, or in rough receptacles made of Portland cement or suitable pieces of stone cemented together, as they can then be moved or taken out when searching for objects without disturbing the growth of the plants.

While in the aquarium tank but few kinds of aquatic plants can be grown without great care and under the most favorable conditions, any water-plant whatever may, by means of these aqua-vivaria, be propagated successfully. The writer maintains, on the test of sufficient experience, that all the conditions favorable to life, animal and vegetable, of the largest pond may be had in this manner at trifling cost, and that undoubtedly many of the vexed questions of biology might readily be solved in this way. The great obstacle in the way of biological research is generally the limited amount of material obtainable, while rare forms are often unattainable for long periods.

One barrel of Portland cement and two bushels of sand, mixed, costing less than $5, will line a trench at least 4 by 20 feet, and from 6 to 18 inches in depth. The water supply may be had from hydrant, spring, raceway, or any available source. All the water needed, after filling, is to supply the loss by evaporation and the small amount which may at first percolate through the cement. Instead of a large basin a series of smaller ones of varying dimensions might prove better adapted to animals of different natures which might prey upon one another. In constructing homes for animals of widely divergent habits there is no plan other than that here proposed, which allows of such diversity of arrangement. The aquarium tank is costly, and, by reason of its too great and unvarying depth, and its perpendicular sides, is really unsuited for much else than ornament. It is difficult of arrangement for various forms of life, and is too subject to changes of temperature. In some experiments in fish culture the writer found that in a trench, such

as here described, of a depth of from 10 to 18 inches, and in which were growing *nymphæa* and other aquatic plants, although exposed all day to the heat of the summer sun, the temperature of the water never rose above 50° to 60°, except to from 2 to 3 inches from the surface. And while the water was swarming with young fish there was no sign of oppression to their respiratory organs, while in an aquarium tank, out in the open air in the shade, with a much smaller number of fish proportionately, the temperature of the water was always about that of the atmosphere, and the fish showed signs of more or less oppression throughout the day.

Many of the lower forms of life, such as the chelonians, batrachians, ophidians, &c., require sand patches or mossy rockeries, in which to deposit their ova and in which their natural food may propagate and be sought for by them. It is these conditions, so easily obtainable, which produce contentment and the normal discharge of the natural functions which are the subject of the biologist's investigations.

Fronts of glass might be of advantage in these aqua-vivaria in some cases, but are not generally necessary; the only objection to them, however, is the extra expense entailed without adequate advantages. With the graduated depths of water, the natural and healthy growth of plants, the natural distribution of light and temperature, and the pure and clear water obtainable by these methods, there is no difficulty in observing the habits of animals, as they soon lose their timidity when accustomed to the presence of man.

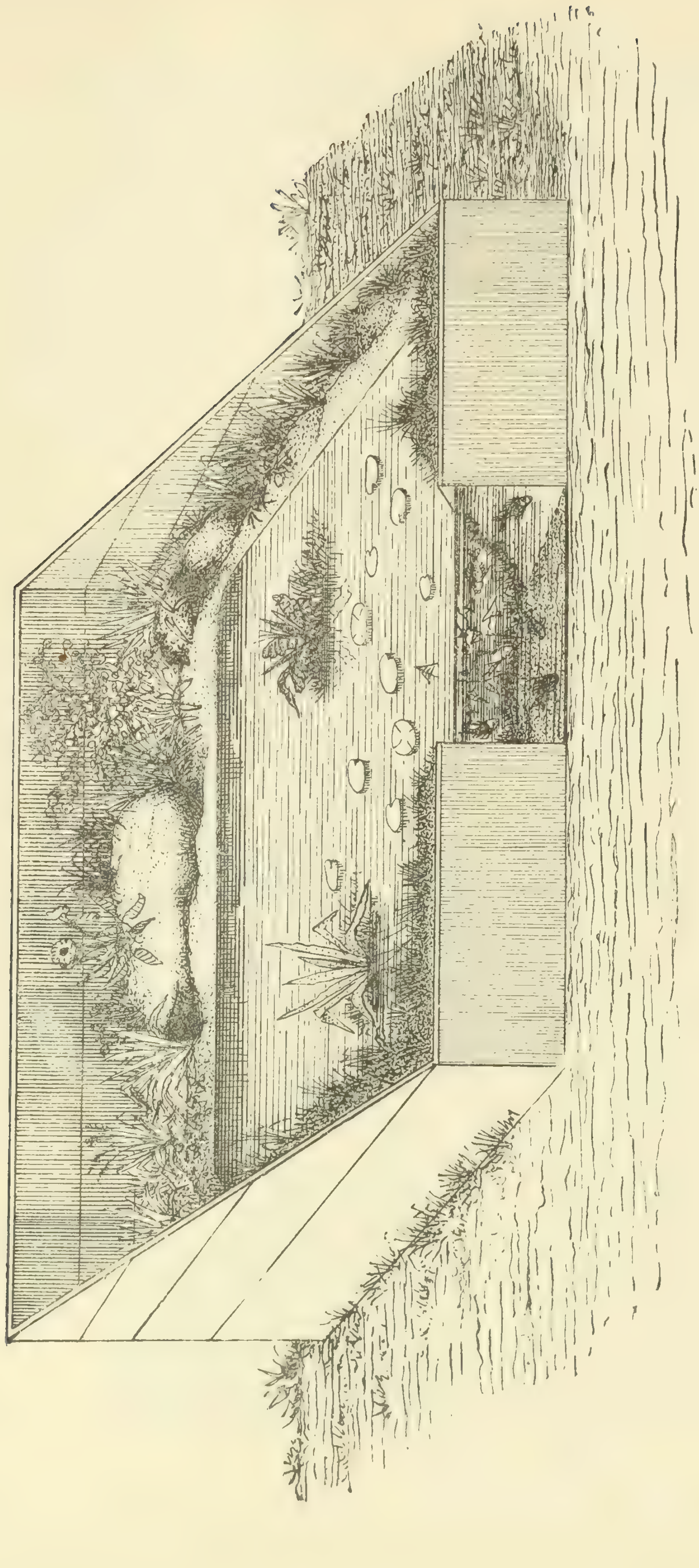
Plates II and III will serve sufficiently well to illustrate more elaborate forms of aqua-vivaria or combinations of such as the greenhouse plan, showing adaptations absolutely impossible with the aquarium tank for diverse forms of life. Rockeries properly constructed to prevent the escape of animals, mimic waterfalls, beds of mosses, or grasses and ferns, combine in such close imitation of nature that the animals readily accept them as habitats. Water may be supplied by running a pipe above with a cock for each basin, thus making each basin independent of the others. It may be introduced without agitation, or made to tumble over rock-work, or it may be supplied at one end and made to circulate through an entire series of basins by making a trough-like connection between the basins with wire-gauze guards. A pipe may be inserted in the bottom of each basin, with a stop-cock outside for emptying the basin speedily when desired. With an elevated reservoir, and windmill or other power to pump back the waste water, an economical aqua-vivarium might be had. These methods are alike adapted to the simple wants of the individual specialist or to the multifarious requirements of the greatest university.

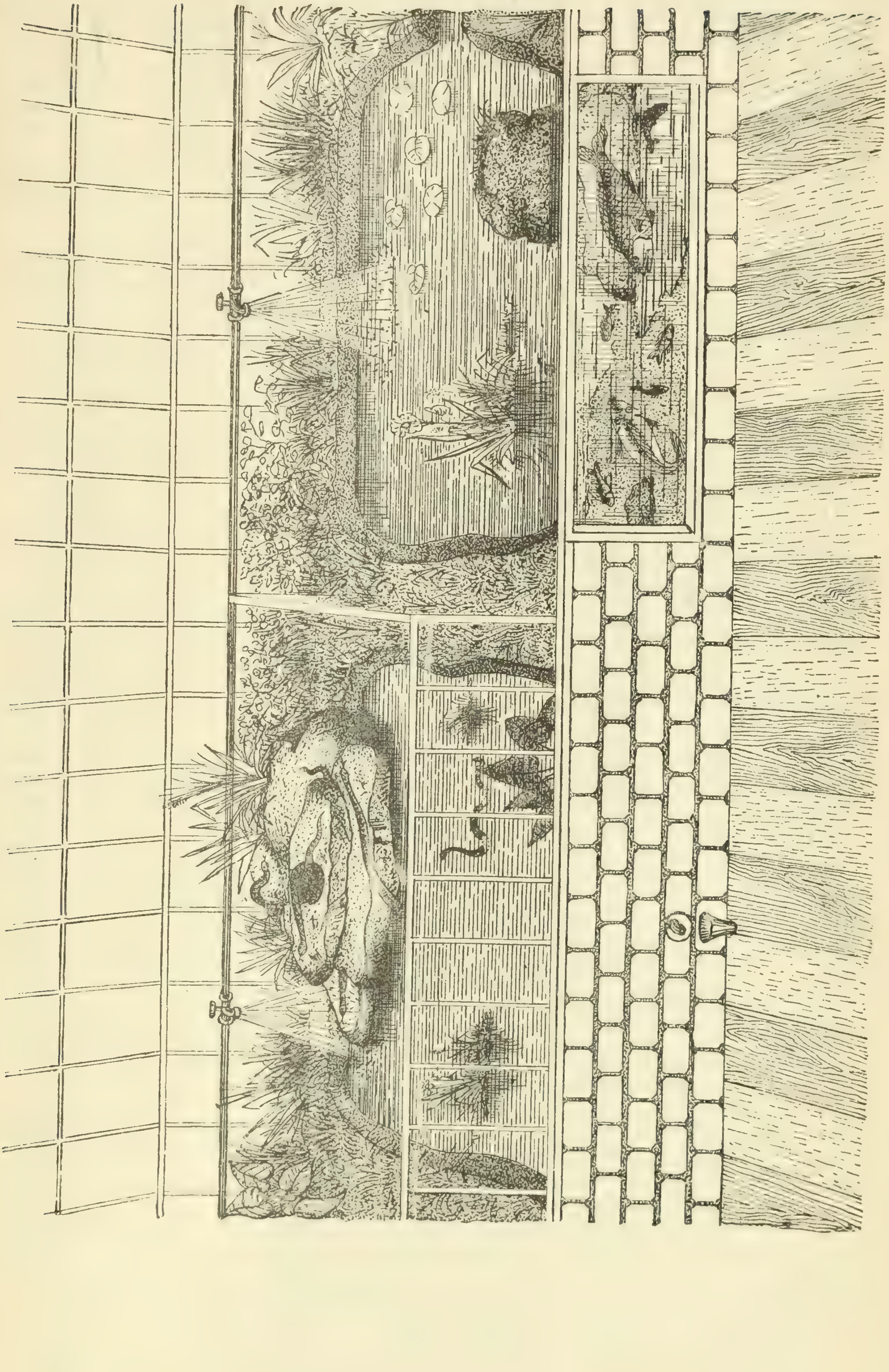
The question of food is fully as important as are those of light and temperature. Many fish and reptiles will refuse all food which they do not kill themselves. Others will feed readily on dead animal food. Others, again, will thrive upon prepared vegetable or farinaceous food.

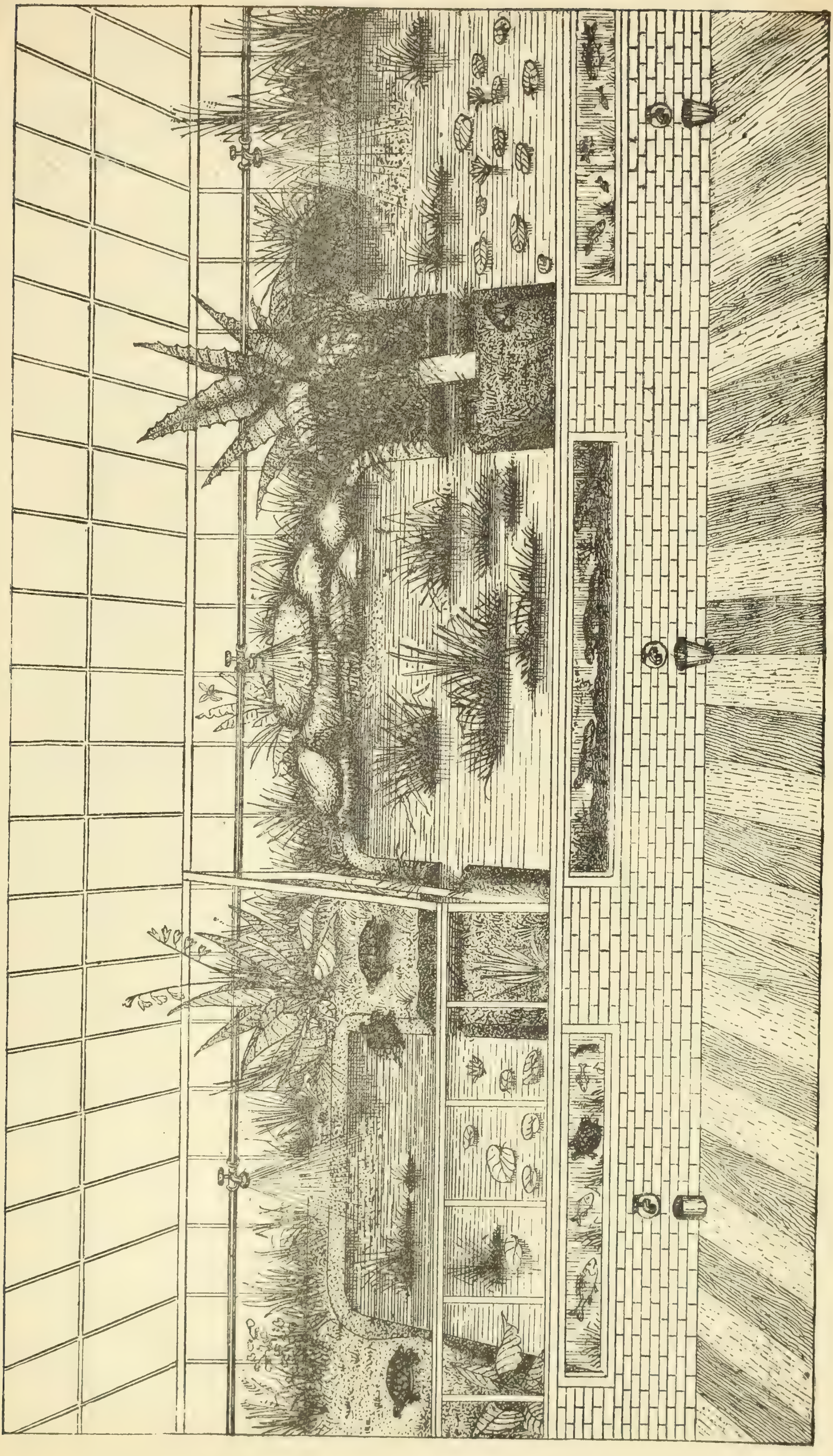
The young of animals inhabiting the water seem, in a greater degree, to require living objects as food. These they find in the myriads of animalcules, crustaceans, larvæ, &c., inhabiting quiet waters or the quiet parts of waters. Many of these, in their turn, prey upon the young fish, reptiles, &c. These minute forms of life may be propagated in incalculable numbers in basins such as are herein described. A basin, for instance, adjoining one in which fish are being propagated, might be used as a propagating basin for their food. These animalcules, &c., could be transferred to the fish-basin by means of a fine net, or the two basins might be separated for an inch or two from the surface by a bed of moss through which the animalcules could find their way to the fish-basin.

A row of tables and shelves with aquariums, jars, microscopes, &c., for purposes of special investigation, could be placed opposite the propagating and storage basins. There would thus be an economical and practically perfect adjunct to the biological laboratory, subject, of course, to the eternal sway of progressive development.

Lansdale, Pa.







APPENDIX E.

PROPAGATION OF FOOD-FISHES.

XXII.—ACCOUNT OF EGGS REPACKED AND SHIPPED TO FOREIGN COUNTRIES UNDER DIRECTION OF THE UNITED STATES FISH COMMISSION DURING THE SEASON OF 1883-'84.

By Fred Mather.

GERMANY.

On January 10, 1884, I received at Cold Spring Harbor, N. Y., several packages from Mr. F. N. Clark, superintendent of the Northville hatchery, containing 1,000,000 whitefish eggs, 25,000 brook trout eggs, and 25,000 lake trout eggs, all in good condition. I removed the eggs from the sawdust packing, picked out a few dead ones, and repacked them in ice. On the 12th they were shipped to Herr von Behr, president of the Deutsche Fischerei-Verein, Berlin, in care of F. Busse, Geestemunde, by the North German Lloyd steamer Neckar. A letter from Herr von Behr subsequently stated that these eggs arrived in excellent condition.

On March 20 I received a box containing 12,000 eggs of the rainbow trout from Mr. Clark for shipment to Germany. These were too far advanced for shipment, many having already hatched on the way and died. I had in the hatchery a lot of the same species belonging to the New York fish commission. These had been received on March 21 from the Caledonia station, and were not quite so far advanced, although rather old for shipment abroad. I placed Mr. Clark's eggs in the trough, and in their stead packed and shipped the New York eggs on the North German Lloyd steamer which sailed on March 29. These eggs did not arrive in good order. At first Herr von Behr wrote that he did not think that a single egg would give a healthy fry, but afterwards said that they had done better than was at first anticipated.

SCOTLAND.

On March 6 I received a package of 5,000 eggs of the landlocked or schoodic salmon from Mr. Charles G. Atkins, Grand Lake Stream, Maine, and repacked and shipped them to Sir James Gibson Maitland, Bart., Stirling. On the 8th of April I received a letter dated Stirling, March 21, 1884, containing the following report: "I am glad to inform you that the landlocked salmon ova arrived here in first-rate condition; only about twelve white eggs, ten of which were unimpregnated."

ENGLAND.

On April 14 I received 3,000 eggs of the rainbow trout from Mr. F. N. Clark, Northville, Mich., and on the 18th repacked and shipped them by steamer Assyrian Monarch to Edward Birbeck, esq., secretary of the National Fish-Cultural Association, London. The agents of the Monarch line informed me that the eggs would be placed in the beef-room (this line has chill-rooms, and carries great quantities of dressed beef to England), and the temperature of this room was said to be kept between 33° and 38° F. As the beef is not permitted to freeze, I thought this arrangement the very best that could be made, but a letter from Mr. Birbeck informs me that the eggs arrived frozen and dead.

FRANCE.

At the same time of receiving the above-mentioned eggs I received 3,000 eggs of the rainbow trout from Mr. Clark, and on April 15 shipped them to C. Raveret-Wattel, secretary of the Société d'Acclimatation, Paris, by the steamer Normandie of the General Transatlantic Company. A letter from Mr. Raveret-Wattel states that the eggs arrived in most excellent condition.

XXIII.—REPORT OF OPERATIONS AT NORTHVILLE AND ALPENA STATIONS FOR THE SEASON OF 1883-'84.

By Frank N. Clark.

PRELIMINARY WORK.

The work at the Northville Station from the beginning of the fiscal year until about the middle of August consisted only of the usual routine—cleaning and repairing ponds, assorting the stock of fish, &c. Two hands of the winter working force were retained through the summer, and were kept quite busy with that work. All the breeding fish were placed in ponds connected with race-ways, and the fry in the others. The floats which had been used on the ponds to furnish shade were found to gather a considerable amount of fungoid matter, which sloughed off and polluted the water; we therefore had them removed and constructed shades of boards laid on sleepers extending across the ponds.

The volume of water being inadequate to the increased amount of work laid out for the season, we found it necessary to adopt apparatus that would increase its availability. A supply of McDonald's closed jars was obtained, and the tanks rearranged for their accommodation. These jars are specially adapted to the use of a limited water supply, as they can be arranged to run the same water through several of them. With the open jars the water can only be used once, unless there is fall enough to admit of placing several tiers of jars one above the other. The work of reconstructing the tanks and placing the jars was completed and the hatchery ready for the reception of eggs by the 1st of November.

THE WHITEFISH WORK.

The first installment of whitefish eggs—four cases—was received at Northville, from the islands in Lake Erie, November 14, and the first arrival at Alpena was received November 5. Although the bad weather caused a very light catch of fish in the lower lakes, we had a supply of eggs greatly in excess of that of any former year, owing to our much more extensive arrangements for obtaining them. The heavy storms which prevailed on all the lakes from the 10th to the 15th of November effectually stopped the pound-net fishing, and our only supply after that time was derived from the gill-net work in Lake Huron. It is a fact well known by fishermen that when the whitefish are driven from their coast spawning grounds by storms they will not return during the season.

This is considered so certain that as soon as the storm abates the fishermen withdraw their nets not destroyed by the wind and waves and abandon the fishing grounds for the season. No more fishing is then done in our territory except with gill-nets in some parts of Lake Huron. It was from this source that all the supply was obtained, after the storms above mentioned, from the shoals at the mouth of Thunder Bay. The shoal run is a short one, beginning about November 18, and with it closes the white-fish season. The fishing in the shoal grounds grows lighter with each successive season. This is attributed by fishermen to overfishing and to the yearly loss of many nets with fish fast in them, which decay and foul the bottom. The water being but 3 to 8 fathoms in depth and the bottom rocky, the nets are destroyed by a very moderate sea and current.

Although the fishing was very light on the western shore of Lake Huron, very heavy catches were made on the Canada side, around Cockburn and the Duck Islands, and on the coast reefs in Northern Lake Michigan, and the reefs west of Mackinaw Straits, between Beaver Islands and the north shore. Fishing on the latter reefs is done with pound-nets; but as there is no shore to lead from, the nets have four leaders radiating at right angles. Three to six tons were taken from these nets at each lift during the season. Two men were sent there at the beginning of the season, but found no ripe eggs the first day. On the second day, they took about half a million good eggs, and on the third day the operations were brought to an abrupt ending by the storm. Some heavy catches were made at Duck Island, in Canadian waters. Just before the storm, the propeller Roberts passed down from there with about 45 tons of whitefish and trout. The whitefish of that locality are of a large type, specimens weighing 15 to 20 pounds being frequently taken. The captain of the Roberts mentions one that weighed 26 pounds.

The Lake Erie catch previous to the storm was up to the average. The fall fishing is done with pound-nets leading from the coast and island reefs, so that there was no chance to collect eggs there after the storm, as at Alpena, where there was subsequent fishing with gill-nets.

The experiment of holding whitefish in inclosures until they ripened was quite successful, although it was not conducted on a scale large enough to add greatly to our crop of eggs. The funds not being sufficient to provide suitable harbors adjacent to the fisheries, the fish were placed in floating crates, and it was not deemed advisable to place a large number of fish in them, where they were liable to be destroyed by wind and waves. Two crates were used at North Bass Island in Lake Erie, and two at the Alcona fisheries in Lake Huron. The former were anchored about twenty rods from the beach, in about twelve feet of water; the latter in a small bay partially protected from the lake seas. The fish confined in them yielded about five or six million eggs, and not one died while in the crates, but a few—twenty-five or thirty, per-

haps—escaped through a hole made in one of the crates by floating drift-wood.

For the successful confinement of immature whitefish, it is absolutely essential that the floating crates be placed within protected inclosures, in pure water of suitable depth.

AT THE NORTHVILLE HATCHERY.

The first whitefish eggs were received at this station, from Lake Erie, November 14, arriving in good condition. There were four cases, filling eighteen McDonald jars. More eggs were expected on the 15th, but the steamer which brought them was windbound, and they did not arrive at the hatchery until the 17th, when they were found to be badly frozen, and could not be removed from the trays until thawed. We found an unexpected difficulty in the use of the closed jars. Air would find its way into the jars, forming bubbles which passed rapidly through the tubes, conveying many of the eggs into the tank. We had considerable trouble trying to remedy this evil, and occasionally found a jar entirely emptied. After considerable experimenting we overcame this trouble by so arranging the jars as to increase the water pressure.

The last lot of eggs direct from the fishing grounds was received December 1, making 25,000,000, which, with 35,000,000 received in several installments from the Alpena hatchery, made the total number handled at this place 60,000,000. Of this number, about 12,000,000 were shipped to various points, and 8,000,000 lost in various ways; the total number of whitefish hatched at this point was therefore 40,000,000.

SHIPMENTS.

Whitefish eggs were sent to various points as follows:

Date.	Where shipped.	Number of eggs.
Dec. 11	Central Station, Washington, D. C	1,000,000
15	Central Station, Washington, D. C.	1,000,000
Jan. 7	Anamosa, Iowa	1,200,000
7	Germany	1,000,000
8	New Zealand	1,000,000
14	Raleigh, N. C	500,000
15	Hillsborough, Md	200,000
16	Plymouth, N. H	200,000
18	New York	100,000
19	Saint Paul, Minn	2,000,000
21	Cold Spring Harbor, N. Y	900,000
31	Saint Paul, Minn	1,000,000
Feb. 6	Saint Paul, Minn	2,000,000
	Total number sent away	12,100,000

It is to be regretted that all recipients of eggs do not acknowledge receipt of same, stating condition on arrival and other particulars. All reports received, including those from New Zealand and Germany, were very favorable. The former shipment left Northville January 8, and was accompanied by me to Omaha, whence it went by express to San Francisco, in care of R. J. Creighton, arriving there January 13; thence by steamer to New Zealand, arriving February 16.

HATCHING AND DISTRIBUTION OF FRY.

The eggs received from Alpena arrived in good condition. In order to retard the hatching, a considerable portion of the eggs were kept in a refrigerator through December, and in order to preserve them in good condition they were taken out and washed once a week. This prevented the inconvenience of having them hatched faster than we could take care of them. A few fry appeared early in February, but the number was very small until the 16th, when the record shows that there were about 2,000,000 in the tanks. One million more were hatched on the 17th; and on the 20th, Car No. 2, in charge of J. F. Ellis, left for Manistee with 3,000,000, and on the 22d for Grand Haven with 3,000,000; on the 25th to Erie, Pa., with 3,000,000, which nearly exhausted the supply. The weather was very cold for the next few days, and eggs hatched very slowly. No more shipments were made until March 3, when the car went to Traverse City with 3,000,000. The hatching continued slowly, but another 3,000,000 were sent on the 10th to Oswego, N. Y., and an equal number on the 14th to Port Huron. Hatching was by this time going on more rapidly, and the car was kept going quite lively in its work of distribution; 3,000,000 more went to Oswego on the 17th, and 3,000,000 on the 20th to Ludington, Mich. The rest of the shipments were as follows: March 22, Port Huron, 3,000,000; 23, Monroe, 3,000,000; 25, Bass Islands, 3,000,000; 30, west shore of Lake Michigan, 4,000,000; Bass Islands, April 8, 3,000,000; making a total of 40,000,000 whitefish fry sent out and planted in good condition.

THE WORK AT ALPENA.

This station is supplied with water from the city water-works, which enables us to have a higher head and greater pressure. We can therefore do the work with much less water and with less trouble with the closed jars than at Northville. The hatchery is equipped with both McDonald and Chase jars, the latter placed in six tiers, one above the other, the highest being near the ceiling, and the same water passing through all. We were not able to detect any difference in the hatching in the upper and lower tiers.

The supply of eggs was derived from the following sources:

	Jars.
Round Island, 9 pound-nets	9
Nine-Mile Point, 6 pound-nets	16
Hammond's Bay, 16 pound-nets	55
Oscoda, 4 pound-nets	16
Alcona, 11 pound-nets	148
Beaver Islands, 10 pound-nets	8
Ossineke, 8 pound-nets	5
Scarecrow Island, 4 pound-nets	5
Total from pound-nets	262
From gill-nets in various grounds	113
Total from all sources	375

Of the above supply of eggs, 32,000,000 were hatched at Alpena, and the remainder shipped to Northville, as it was much cheaper to ship the eggs than the young fish, which would have to be sent to some railroad point where the car could reach them. The larger part of the fry from this station were planted along the west coast of Lake Huron, in the vicinity of Thunder Bay. The first shipment, 2,000,000, were planted off North Point in above bay, April 15. On the 17th 2,000,000 were planted near Scare Crow Island, in said bay; April 18, 2,000,000 near Alcona; April 20, 4,000,000 near Round Island and the shoal reefs; April 21, 4,000,000 more went to Alcona; April 23, 4,000,000 were sent to Bay City by boat, whence they were taken by car to Apostle Islands, Lake Superior, near Ashland, Wis. They were deposited on the 26th. April 25, 2,000,000 were planted near Oscoda, Lake Huron; April 27, 2,000,000 in Hammond's Bay; April 29, 3,000,000 in Lake Huron, at Ossineke and Harrisville; April 30, 2,000,000 by boat to Saint Ignace, and thence by baggage car to Marquette, Lake Superior, where they were planted May 1; May 3, 4,000,000 were taken to Bay City, thence by car, via Chicago, to Escanaba, Lake Michigan, reaching their destination on the 6th. On May 4, 250,000 were planted in Taylor's Lake, inland, 4 miles from Alpena; May 5, 500,000 near Sulphur Island, Thunder Bay; same day, 250,000 in Black River Lake, 12 miles inland from the village of Black River, which closed the whitefish work at this station.

THE TROUT WORK.

The operations with trout are carried on quite extensively at this station, where the cold spring water is well adapted to their growth. The brood trout are kept in ponds, described in previous reports, adjacent to the hatching-house. There are also a large number of wild trout of both the brook and rainbow species in the stream—a branch of the river Rouge—which runs near the hatchery. In the mill pond, a short distance below, we caught and obtained eggs from 33 female brook trout. On examination of our trout in the ponds July 1, we found that the fry and yearlings had grown very rapidly, and seemed to be larger for their age than in any previous year. The usual work of sorting and counting the fish was completed July 30, showing the following result:

German trout fry in nursery tank (estimated)	1,400
Land-locked salmon, fry	100
Brook trout in tank in house, fry	325
Brook trout in pond C, fry	9,697
Brook trout in pond F, yearlings	1,980
Brook trout in pond D, two years old	573
Brook trout in pond B, three and four years old	500
Rainbow trout in pond H, fry	6,000
Rainbow trout in pond G, yearlings	2,777
Rainbow trout in pond E, two and three years	575
Goldfish in pond A (estimated)	150
Whitefish in tank in house	280

BROOK TROUT.

This branch of our work is the most useful and profitable branch of our trout department. Our record of handling last year is as follows: 260 wild trout were taken from the creek near the hatchery, and of this number 33 ripe females were found, from which 18,000 eggs were taken. The first eggs from wild trout were taken October 10, and the last, November 21, covering a period of forty-one days. Pond fish were handled as follows: Of fish twenty months old, 346 females were handled, from which 81,000 eggs were obtained; first eggs were taken October 9; last ones, December 20; period of taking, forty-one days. Of fish thirty-two months old 160 females were handled and 86,000 eggs obtained; first eggs taken October 27; last, December 12; period, forty-five days. Of fish three and a-half years old 110 females were handled and 110,000 eggs obtained; first eggs taken October 24; last, December 10; period, forty-seven days.

The eggs from the wild trout were hatched in January and February, and the fry planted in the stream adjacent to the hatchery.

SHIPMENT OF EGGS.

On December 18, we sent 75,000 brook trout eggs to the Central Station, Washington, D. C.; January 7, 25,000 to Fred. Mather, New York, for reshipment to Germany; January 19, 75,000 to Central Station; January 28, Nebraska commission, South Bend, Nebr., 6,000, and 6,000 to Henry T. Root, Providence, R. I.; January 29, Minnesota commission, Saint Paul, Minn., 6,000; Maryland commission, Baltimore, 6,000; Connecticut commission, Poquonock, 12,000; Cold Spring Harbor hatchery, Long Island, 6,000; Iowa commission, Anamosa, 6,000.

LAKE TROUT WORK.

The catch of lake trout from the big reef in Central Lake Huron and other trout reefs, and landed at various points along the lake shore, was a large one, compensating largely for the light run of whitefish to the coast, and prevented a heavy loss to fishermen on the American side, as the coast catch of the latter fish was insufficient to pay expenses. The best day's fishing of the season was November 7, when six tugs brought in about twenty tons of trout as the result of the day's lift.

The fish spawned this season much later than usual. When the last eggs were taken, November 18, a good many hard fish were reported. The number of eggs taken and sent to Northville was 280,000. Shipments from here were as follows: December 11, 100,000 to Central Station, Washington, D. C.; January 7, 25,000 to Von Behr, Germany, through the hands of Mr. Fred. Mather, Newark, N. J. Both shipments arrived at their destination in good condition. About 105,000 eggs were hatched here, and 75,000 of the fry were distributed by car No. 2, which left Northville April 11. The fry were delivered the same

day—one-half in Star Lake, one-fourth in Strawberry Lake, and the remaining fourth in Crooked Lake, all in Northern Michigan. Thirty thousand were delivered to Mr. Bassett, who deposited them in Arnold's Lake, Washtenaw County, Michigan.

PENOBSCOT SALMON.

Mr. Charles G. Atkins, of Maine, sent a case of 30,000 eggs of this species to this station. They arrived February 28 in good condition, only three dead eggs being found on unpacking them, and the subsequent loss was 105. The first fish were hatched March 16, and the last on March 24. The loss of fry in hatching was about 600, and the remainder, something over 29,000, was planted May 25 in headwaters of the Huron River, near the village of Walled Lake, Oakland County, Michigan.

RAINBOW TROUT.

As an instance of the climatic effect of transfer, our rainbow trout have so far changed their habits as to become winter spawners, and we believe that in a few years their spawning will occur simultaneously with the brook trout. The period of taking eggs extended from December 19 to March 31, but the largest portion was taken in January and February. We got about 125,000 eggs, but could not succeed in fertilizing more than one-fourth of them. The results were better than last season, but far from satisfactory. We shipped away 18,000 eggs and hatched 10,000, retaining 4,000 of the fry for breeding stock. Eggs and fry were shipped as follows: March 24, to Fred. Mather, New York, for reshipment to Herr Von Behr, Germany, 12,000 eggs; April 11, to Mather, 6,000 eggs, one-half of which were to be forwarded by him to Société d'Acclimatation, Paris, and the other half to the Fish Cultural Association, London, England. On May 12, 2,500 fry were sent to A. C. Lanier, of Madison, Ind.; May 23, 1,000 to J. E. Bassett, Saline, Mich.; May 30, 2,500 to A. L. Delano, Mount Vernon, Ohio.

When the eggs intended for European destinations reached New York, Mr. Mather found that they had become overheated, and that all were too far advanced to ship. He therefore exchanged them for an equal number of less advanced eggs from the Cold Springs Harbor station, which he forwarded. The German consignment arrived in poor condition. We have received no reports from the other two lots.

A case of 4,000 rainbow trout eggs was received March 18 from the Central Station at Washington, where they had been sent direct from the McCloud River Station, in California. They reached here in prime condition, and hatched soon after arrival. The fry were retained here for a breeding stock.

GERMAN TROUT.

On February 18 we received a case of 5,000 eggs of German trout (*Salmo fario*), which arrived in good condition. They hatched about the middle of March, and were taken April 11, in car No. 2, and planted in a branch of the Pere Marquette River, in Northern Michigan.

RECAPITULATION.

The following table combines the work of both stations for the season:

Fish.	Eggs taken.	Eggs received from other sources.	Eggs shipped.	Fish hatched.	Fish shipped or deposited.
German trout	....	5,000	....	4,900	4,900
Rainbow trout	125,000	4,000	18,000	14,000	6,000
Brook trout	295,000	....	223,000	20,000	15,000
Lake trout	280,000	....	125,000	105,000	105,000
Penobscot salmon	....	30,000	....	29,900	29,200
Whitefish	100,000,000	....	12,100,000	72,000,000	72,000,000

Whitefish eggs were shipped to States and countries as follows:

Minnesota	5,000,000
Iowa	1,200,000
Maryland	200,000
North Carolina	500,000
New Hampshire	200,000
New York	1,000,000
Central Station, Washington, D. C	2,000,000
Germany	1,000,000
New Zealand	1,000,000
Total	12,100,000

Whitefish fry were distributed as follows:

Lake Ontario	6,000,000
Lake Erie	12,000,000
Lake Huron	27,500,000
Lake Michigan	20,000,000
Lake Superior	6,000,000
Inland lakes near Alpena, Mich	500,000
Total	72,000,000

Record of temperature observations made at the United States Fish-Hatching Station at Northville, Mich., from October 3, 1883, to April 15, 1884.

Day of month.	Temperature of—						Wind.						Sky.		
	Water.			Air.			Direction.			Intensity.			Condition of.		
	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p m.	8 a. m.	12 m.	5 p. m.
1883.	°	°	°	°	°	°									
Oct. 3	48	52	53	41	60	43	NW.	NW.	NW.	Brisk	Calm	Brisk	Clear	Clear	Clear.
4	46	50	53	33	56	42	NW.	NE.	NE.	Light	...do	Light	...do	Cloudy	Cloudy.
5	48	50	52	40	57	50	NE.	E.	E.	...do	...do	Calm	Cloudy	...do	Do.
6	49	50	50	46	56	50	SE.	SE.	E.	...do	...do	...do	...do	...do	Do.
7	59	52	50	46	57	52	NE.	SE.	S.	Calm	...do	...do	...do	Clear	Do.
8	50	54	56	46	78	60	SW.	SW.	SW.	Brisk	...do	...do	Fog	Cloudy	Do.
9	52	60	62	60	80	76	SW.	SW.	SW.	Calm	Light	...do	Clear	...do	Do.
10	65	64	57	68	68	56	SW.	NW.	N.	Strong	...do	...do	Cloudy	...do	Do.
11	52	58	58	52	63	58	NE.	SE.	SW.	Calm	Calm	Light	...do	...do	Do.
12	53	56	56	55	62	62	NE.	NW.	SW.	...do	...do	Brisk	Misty	...do	Do.
13	52	52	52	49	50	52	NE.	NE.	NE.	Light	Light	Strong	Cloudy	...do	Do.
14	50	50	49	42	42	43	N.	NE.	NE.	...do	...do	Light	...do	...do	Do.
15	46	52	47	36	42	40	NE.	E.	NE.	Calm	Calm	...do	...do	Clear	Clear.
16	46	58	48	34	60	40	NE.	SE.	E.	Brisk	...do	Calm	Clear	...do	Do.
17	44	58	50	34	50	50	NE.	S.	SE.	Light	...do	...do	...do	...do	Cloudy.
18	48	50	50	52	58	56	SW.	SW.	SW.	...do	...do	...do	Cloudy	Cloudy	Do.
19	53	54	54	59	68	60	SW.	SW.	SW.	...do	...do	...do	...do	...do	Do.
20	48	49	47	36	42	40	NE.	NW.	NE.	Brisk	Light	Brisk	...do	...do	Do.
21	45	46	44	36	56	39	NE.	NE.	NE.	Strong	Brisk	...do	...do	...do	Do.
22	44	46	45	38	46	37	NE.	NE.	E.	Light	Light	Calm	Clear	...do	Do.
23	46	46	46	38	48	42	NE.	NE.	NE.	Calm	Calm	...do	Cloudy	...do	Do.
24	46	48	47	40	48	45	E.	NE.	NE.	...do	Light	...do	...do	...do	Do.
25	47	49	48	43	48	47	NE.	E.	NE.	Brisk	Calm	Light	...do	...do	Do.
26	46	47	50	42	52	47	NE.	E.	NE.	Light	...do	Calm	...do	...do	Do.
27	45	49	48	30	54	46	NE.	E.	E.	Calm	Light	...do	Clear	...do	Do.
28	48	49	49	46	52	50	NE.	SE.	SE.	Light	...do	Light	Cloudy	...do	Do.
29	50	50	52	56	64	52	SE.	SW.	NW.	...do	Brisk	Brisk	...do	...do	Do.
30	48	49	50	56	56	54	SW.	NW.	NW.	Brisk	Strong	Light	Clear	...do	Do.
31	48	47	46	40	42	40	NW.	W.	W.	Light	...do	Strong	...do	...do	Do.
Nov. 1	44	43	46	36	40	40	NW.	NW.	W.	Brisk	...do	...do	Cloudy	...do	Do.
2	44	45	46	38	42	34	NW.	NW.	W.	Light	Light	Calm	...do	...do	Do.
3	42	44	44	34	39	38	W.	W	W.	...do	...do	Light	...do	...do	Clear.
4	48	48	50	48	54	50	SW.	SW.	SW.	...do	Brisk	Brisk	...do	...do	Cloudy.
5	50	50	50	44	46	48	W.	SW.	SW.	...do	...do	Strong	...do	...do	Do.
6	50	49	48	45	45	42	SW.	W.	N.	Strong	Light	Light	Clear	...do	Do.
7	45	46	48	27	46	50	W.	SW.	SW.	Calm	Strong	...do	...do	Clear	Do.
8	46	47	48	38	48	49	E.	SW.	SW.	...do	Light	...do	Cloudy	...do	Clear.
9	48	50	50	49	58	48	SW.	W.	SW.	Light	Strong	...do	...do	Cloudy	Do.

Record of temperature observations made at the United States Fish-Hatching Station at Northville, Mich., &c.—Continued.

Day of month.	Temperature of— Water. 8 a.m.	Water. 12 m.	Water. 5 p.m.	Air. 8 a.m.	Air. 12 m.	Air. 5 p.m.	Wind. Direction. 8 a.m.	Direction. 12 m.	Direction. 5 p.m.	Intensity. 8 a.m.	Intensity. 12 m.	Intensity. 5 p.m.	Sky. Condition of. 8 a.m.	12 m.	5 p.m.
1884.	°	°	°	°	°	°									
Nov. 10	49	50	49	41	50	46	SW.	W.	NW.	Light	Light	Light	Clear	Cloudy	Clear.
11	46	48	46	36	52	48	NW.	SW.	NW.	do	Brisk	Strong	do	Clear	Do.
12	40	38	38	25	28	27	SW.	NW.	W.	High	Strong	do	do	Cloudy	Do.
13	38	42	43	30	46	40	W.	W.	W.	Strong	do	do	do	Clear	Cloudy.
14	34	36	36	19	23	21	SW.	NW.	W.	do	do	do	do	Cloudy	Do.
15	34	34	34	15	20	16	W.	W.	W.	Light	High	Brisk	do	do	Do.
16	34	37	38	9	20	19	SW.	W.	SW.	do	Brisk	do	do	Clear	Clear.
17	37	39	38	23	38	36	SW.	SW.	SW.	Brisk	do	do	do	do	Do.
18	40	42	43	38	39	44	SW.	SW.	SW.	Light	Light	Light	Cloudy	Cloudy	Cloudy.
19	41	46	47	30	41	43	SW.	SW.	SW.	do	do	Calm	Clear	Clear	Clear.
20	44	45	48	38	50	54	SW.	S.	SW.	Calm	do	Light	Cloudy	Cloudy	Cloudy.
21	52	52	52	55	62	62	W.	SW.	SW.	Light	do	do	do	do	Do.
22	50	49	50	44	46	45	NW.	NW.	NW.	Strong	do	do	do	do	Do.
23	48	48	46	46	47	46	SW.	SW.	SE.	Light	Calm	Calm	do	do	Do.
24	48	50	49	46	47	46	SE.	SE.	SE.	do	do	do	do	Clear	Clear.
25	45	47	48	38	48	40	SW.	SE.	SE.	do	Light	do	Clear	do	Cloudy.
26	48	52	48	52	41	35	NW.	W.	W.	Brisk	Brisk	Light	Cloudy	do	Clear.
27	40	40	39	19	26	30	NW.	W.	N. W	Calm	Light	Calm	Clear	do	Do.
28	39	40	40	20	30	29	W.	W.	N. W	do	do	do	do	Cloudy	Cloudy.
29	41	42	42	38	45	42	NE.	NW.	NW.	do	Calm	Light	do	do	Do.
30	43	42	42	40	50	48	SW.	W.	NW.	Brisk	Light	Calm	Cloudy	do	Do.
Dec. 1	42	43	45	30	36	34	NW.	W.	SW.	Light	do	Light	do	do	Do.
2	41	41	41	32	29	26	NW.	NW.	NW.	do	Strong	do	do	do	Do.
3	38	40	40	16	33	30	NW.	NW.	NW.	Calm	Calm	Calm	Clear	Clear	Clear.
4	39	39	42	32	38	42	NW.	NW.	SE.	do	do	do	Cloudy	Cloudy	Cloudy.
5	41	43	46	29	49	48	NE.	SW.	SW.	do	do	do	Clear	Clear	Clear.
6	42	43	44	35	44	36	SE.	S.	SE.	Light	Light	do	Cloudy	do	Cloudy.
7	45	47	47	48	51	52	SW.	SW.	SW.	do	do	Light	do	Cloudy	Do.
8	45	44	43	33	53	49	SW.	W.	NW.	Brisk	do	Calm	do	do	Do.
9	42	44	44	30	43	45	SW.	W.	NW.	Light	do	Light	Clear	Clear	Clear.
10	42	43	44	40	42	40	NW.	NW.	NW.	do	do	Calm	do	Cloudy	Cloudy.
11	41	42	44	32	40	42	W.	W.	W.	do	do	Light	do	Clear	Clear.
12	41	42	46	34	42	40	W.	W.	W.	do	Calm	Calm	Cloudy	Cloudy	Cloudy.
13	42	43	46	36	54	52	SW.	SW.	SW.	do	do	Brisk	Clear	do	Do.
14	44	43	41	34	32	23	NW.	NW.	NW.	do	Strong	do	do	Clear	Do.
15	33	33	34	16	20	21	N.	NW.	NE.	Light	Light	Light	Cloudy	Cloudy	Do.
16	37	37	36	20	14	20	W.	NW.	W.	do	do	do	do	do	Do.
17	34	36	38	6	26	22	NW.	SW.	NW.	Calm	Brisk	do	Clear	do	Do.

	18	36	38	37	22	26	20	NW.	NW.	NW.	Brisk	Light	Calm	Cloudy	do	Do.
	19	36	38	38	14	20	14	NW.	NW.	NW.	Calm	Calm	do	do	do	Do.
	20	37	38	38	14	24	18	W.	SW.	W.	do	do	do	do	Clear	Do.
	21	38	38	38	18	28	22	SW.	SW.	SW.	Light	Light	Brisk	do	Cloudy	Do.
	22	37	37	37	9	20	19	NE.	W.	SE.	Calm	Calm	Light	do	do	Do.
	23	36	35	35	18	24	28	SE.	SE	W.	Brisk	Brisk	Brisk	do	do	Do.
	24	38	39	38	32	35	30	W.	NW.	W.	Light	Light	Calm	do	do	Do.
	25	38	39	38	24	33	30	SW.	NW.	SW.	do	do	Light	do	do	Do.
	26	38	38	40	26	41	36	SW.	SW.	NW.	Brisk	do	Calm	do	do	Clear.
	27	40	38	38	34	26	20	NW.	NW.	NW.	Calm	Brisk	do	do	do	Do.
	28	36	38	39	16	26	16	NW.	SW.	SW.	do	Light	do	do	Clear	Do.
	29	37	38	38	—4	33	26	E.	SE.	SE.	do	Calm	do	Clear	Cloudy	Do.
	30	39	40	40	35	38	36	E.	SE.	NE.	do	do	do	Cloudy	do	Cloudy.
	31	42	42	42	32	37	31	NE.	NE.	NE.	Light	Light	do	do	do	Do.
Jan.	1	38	37	35	21	25	24	NE.	NE.	NE.	do	Strong	Strong	do	do	Do.
	2	34	34	33	22	—27	—26	SW.	W.	NW.	Strong	Brisk	Brisk	do	do	Do.
	3	32	32	35	4	3	3	NW.	NW.	NW.	do	do	do	do	do	Do.
	4	35	36	36	— 3	9	—3	W.	NW.	NW.	Brisk	do	Light	do	do	Do.
	5	36	37	36	0	12	8	NW.	NW.	NW.	Light	Light	Calm	do	do	Do.
	6	36	36	36	— 5	11	3	NW.	W.	W.	do	do	Light	do	Clear	Clear.
	7	36	36	36	6	22	12	NW.	SW.	W.	do	do	Calm	do	Cloudy	Cloudy.
	8	38	38	39	—12	20	15	NE.	NE.	NE.	do	do	do	do	do	Clear.
	9	35	35	36	16	23	19	NW.	NW.	NW.	Strong	Brisk	do	Clear	do	Do.
	10	36	37	37	10	30	30	E.	SE.	SE.	Calm	Light	do	Cloudy	do	Cloudy.
	11	38	38	37	23	29	22	W.	NW.	SE.	Light	Calm	do	do	do	Do.
	12	37	37	38	13	23	20	SW.	SW.	SW.	do	Light	Light	do	do	Clear.
	13	37	38	40	31	44	39	SW.	SW.	W.	Brisk	Brisk	Brisk	do	do	Cloudy.
	14	38	38	38	28	29	21	NW.	NE.	NE.	Light	Light	Light	do	do	Do.
	15	36	36	37	11	17	12	NE.	NE.	NW.	do	Calm	Calm	do	do	Clear.
	16	36	38	38	10	24	20	NW.	SW.	W.	do	Brisk	Light	do	do	Cloudy.
	17	38	37	37	18	29	30	SW.	SW.	SW.	Brisk	do	do	do	do	Clear.
	18	37	39	40	22	36	31	SW.	W.	W.	Light	Light	do	Clear	do	Do.
	19	36	39	35	17	15	11	NE.	NE.	N.	Strong	Strong	do	Cloudy	do	Cloudy.
	20	32	34	35	0	20	12	NW.	NW.	NW.	Brisk	Light	Calm	Clear	Clear	Clear.
	21	36	37	38	10	21	12	SW.	SW.	W.	Light	do	Brisk	Cloudy	Cloudy	Cloudy.
	22	37	38	40	—19	34	28	W.	SW.	NW.	do	do	Calm	do	do	Do.
	23	37	38	38	27	22	14	NE.	NE.	NE.	do	do	Brisk	do	do	Do.
	24	33	33	34	— 3	7	2	NW.	NW.	NW.	Brisk	do	Calm	do	do	Clear.
	25	34	36	37	21	14	9	NW.	NW.	NW.	Calm	Calm	do	Clear	Clear	Do.
	26	37	38	38	13	28	24	SW.	SW.	SW.	Light	do	Light	Cloudy	do	Cloudy.
	27	38	39	39	18	39	24	SE.	SE.	SE.	Calm	Light	do	do	Cloudy	Do.
	28	38	39	39	26	42	39	SE.	SW.	SW.	Light	do	Calm	do	do	Do.
	29	40	40	41	35	40	37	W.	SW.	SW.	do	do	do	do	do	Do.
	30	41	43	47	41	44	46	SW.	SW.	SW.	do	do	Brisk	do	do	Do.
	31	37	38	39	22	32	28	W.	W.	W.	do	do	do	do	do	Do.
	1	35	38	38	8	25	26	NW.	SW.	SE.	Calm	do	Light	do	do	Do.
	2	38	40	41	35	40	31	W.	N.	NW.	Light	do	do	do	do	Do.
	3	39	40	40	26	30	27	NE.	NE.	E.	do	do	do	do	do	Do.
	4	38	38	38	23	27	26	E.	SE.	E.	do	do	do	do	do	Cloudy.
	5	40	41	42	36	38	35	SW.	SW.	SW.	do	do	do	do	do	Do.
	6	40	42	41	30	36	30	E.	SE.	SE.	do	do	Calm	do	do	Do.
	7	40	41	46	25	28	24	E.	NE.	SE.	do	do	Light	do	Clear	Clear.

Record of temperature observations made at the United States Fish-Hatching Station at Northville, Mich., &c.—Continued.

Day of month.	Temperature of—						Wind.						Sky.		
	Water.			Air.			Direction.			Intensity.			Condition of.		
	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.
1884.	°	°	°	°	°	°									
Feb. 8	40	41	43	24	43	34	SE.	SE.	SE.	Calm	Calm	Light	Cloudy	Cloudy	Cloudy.
9	43	45	43	35	33	30	NE.	NW.	NW.	Light	Brisk	do	do	do	Do.
10	39	40	40	17	27	26	E.	NE.	E.	do	Light	Calm	do	do	Do.
11	38	40	39	24	26	28	E.	E.	NE.	do	Calm	Light	do	do	Do.
12	38	39	38	27	31	33	E.	SE.	SE.	do	Light	do	do	do	Do.
13	40	42	42	32	40	38	SW.	SW.	SW.	do	Calm	Calm	do	do	Do.
14	36	37	37	11	18	14	NW.	NW.	NW.	Strong	Brisk	Light	Clear	do	Do.
15	37	40	40	18	22	20	NW.	NW.	NW.	Light	Calm	Calm	Cloudy	do	Do.
16	38	40	42	20	40	38	SW.	S.	S.	Calm	Light	do	do	do	Do.
17	42	43	44	36	38	44	SE.	SE.	SE.	do	Calm	Light	do	do	Do.
18	44	44	45	36	43	38	SE.	SE.	SE.	do	do	Calm	do	Fog	Fog.
19	44	48	48	40	50	48	SE.	SW.	SW.	do	Light	do	Fog	Cloudy	Cloudy.
20	38	36	38	14	26	24	NW.	NW.	NW.	Strong	do	Light	Clear	Clear	Clear.
21	38	38	40	33	27	24	SW.	NW.	NW.	do	Strong	do	Cloudy	Cloudy	Do.
22	37	40	38	24	40	20	SW.	SW.	NW.	Light	Light	do	do	do	Cloudy.
23	38	40	41	20	26	22	NW.	NW.	NW.	Calm	do	do	do	do	Do.
24	38	39	40	20	29	24	SE.	SE.	SE.	Light	do	do	do	do	Do.
25	40	41	43	25	38	26	SW.	SW.	SW.	Calm	do	do	Fog	do	Do.
26	40	42	42	30	36	32	NW.	NW.	NW.	Light	do	do	Cloudy	Clear	Do.
27	40	42	43	24	38	32	NW.	SW.	W.	Calm	Calm	do	do	Cloudy	Do.
28	34	34	45	2	9	3	NW.	NW.	NW.	Strong	Brisk	Brisk	do	do	Do.
29	34	38	39	—10	12	12	NW.	NW.	NW.	Light	Light	Light	Clear	do	Do.
1	38	39	40	4	22	17	E.	E.	E.	do	do	do	Cloudy	do	Do.
2	37	39	40	— 9	25	22	SW.	SW.	SE.	Calm	do	Calm	Clear	Clear	Do.
3	38	39	39	12	22	17	NE.	NW.	NW.	Light	Brisk	Light	Cloudy	Cloudy	Clear.
4	37	39	41	— 4	26	20	W.	SW.	SW.	Calm	Light	Calm	Clear	do	Cloudy.
5	38	40	42	1	32	24	NE.	SW.	SE.	do	Calm	Light	Cloudy	do	Do.
6	40	42	45	22	32	29	NW.	W.	SE.	do	do	do	do	do	Do.
7	41	42	42	22	28	22	NE.	NE.	NE.	Light	Light	Brisk	do	do	Do.
8	36	38	40	20	27	22	NE.	NE.	NE.	Brisk	do	Calm	do	do	Do.
9	38	40	42	21	36	30	NE.	W.	W.	Light	do	Light	do	do	Do.
10	38	39	41	0	15	32	NW.	NW.	SE.	do	do	do	Clear	Clear	Do.
11	41	43	44	36	48	48	SE.	SW.	SW.	Calm	Brisk	Brisk	Cloudy	Cloudy	Do.
12	40	42	44	34	38	34	W.	W.	W.	High	do	do	Hazy	Clear	Clear.
13	40	47	50	34	43	44	W.	SW.	SW.	Light	Light	Calm	Clear	Cloudy	Cloudy.
14	43	45	35	28	35	33	SE.	SE.	NE.	Brisk	do	Light	Cloudy	do	Clear.
15	41	45	46	28	40	35	W.	NW.	NW.	Light	Brisk	Calm	Clear	do	Cloudy.
16	41	43	46	30	41	36	SE.	SW.	SW.	Calm	Light	do	do	do	Do.

17	44	48	48	40	48	43	SW.	NW.	W.	....do	....do	....do	Cloudy	....do	Do.
18	43	48	48	30	42	40	E.	SE.	SE.	....do	....do	Light	....do	....do	Do.
19	45	45	45	36	40	38	NE.	NE.	NE.	Light	....do	....do	....do	....do	Do.
20	44	45	46	36	49	40	N.	NE.	NE.	....do	....do	Calm	....do	....do	Do.
21	44	50	47	34	50	53	SW.	SW.	SW.	Calm	Calm	....do	....do	Hazy	Do.
22	46	50	52	38	56	48	NE.	SE.	SE.	....do	Light	....do	....do	....do	Do.
23	49	55	54	47	62	53	SW.	NW.	NW.	Light	....do	Light	....do	Clear	Clear.
24	48	50	54	36	54	48	NW.	NW.	SE.	Calm	....do	Calm	....do	Hazy	Cloudy.
25	48	48	48	40	46	44	SE.	SE.	SE.	Light	Calm	....do	....do	Cloudy	Do.
26	47	47	47	46	44	44	SW.	W.	NW.	....do	Brisk	Brisk	....do	....do	Do.
27	44	46	55	42	48	56	NW	NW.	SE.	....do	Light	Calm	Clear	Clear	Clear.
28	48	48	49	40	50	49	SE.	SE.	SE.	....do	Brisk	Light	Cloudy	Cloudy	Hazy.
29	47	48	49	41	44	39	NW.	NE.	NE.	Brisk	Strong	Brisk	Clear	....do	Clear.
30	42	46	48	25	38	34	NE.	NW.	NW.	Light	Light	Light	Clear	Clear	Cloudy.
31	48	48	48	44	50	41	SE.	SE.	SW.	Brisk	....do	....do	Cloudy	Cloudy	Do.
Apr. 1	46	46	46	36	38	36	SE.	SE.	E.	Calm	....do	Brisk	....do	....do	Do.
2	42	44	43	32	34	37	NE.	NE.	NE.	Brisk	Brisk	Light	....do	....do	Do.
3	39	48	48	32	44	48	NW.	NW.	NW.	....do	....do	....do	Clear	....do	Do.
4	44	50	52	44	55	52	NW.	NW.	NW.	Light	....do	....do	Cloudy	....do	Do.
5	45	48	51	36	44	48	NW.	NW.	NW.	....do	....do	Calm	Clear	Hazy	Clear.
6	46	50	50	30	45	47	NE.	NE.	NE.	Calm	Light	Light	Cloudy	Clear	Do.
7	46	48	49	34	50	52	E.	SE.	SE.	....do	....do	Calm	Clear	Cloudy	Cloudy.
8	45	51	50	44	50	52	NE.	E.	SW.	....do	....do	Light	Cloudy	....do	Do.
9	45	47	48	36	46	45	N.	NW.	W.	Light	....do	....do	....do	....do	Do.
10	45	49	50	36	50	44	NW.	W.	NW.	Brisk	Calm	....do	Clear	....do	Do.
11	46	46	48	36	46	42	NW.	W.	W.	Calm	Light	....do	Cloudy	....do	Do.
12	50	50	51	36	54	52	NE.	SE.	SE.	....do	....do	....do	....do	....do	Do.
13	50	50	52	40	56	51	SE.	SE.	SE.	Light	Brisk	Calm	....do	Hazy	Do.
14	48	54	55	54	66	60	SE.	SE.	SE.	Calm	Light	Light	....do	Clear	Clear.
15	50	50	52	52	57	54	SE.	W.	SW.	Light	Brisk	Strong	....do	Cloudy	Cloudy.

Temperature of water at Alpena Station from November 1, 1883, *to May* 1, 1884.

Date.	8 a.m.	Date.	8 a.m.	Date.	8 a.m.	Date.	8 a.m.	Date.	8 a.m.	Date.	8 a.m.
1883.	°	1883.	°	1884.	°	1884.	°	1884.	°	1884.	°
Nov. 1	46	Dec. 2	37	Jan. 1	34½	Feb. 1	34½	Mar. 3	34½	Apr. 3	37½
Nov. 2	46	Dec. 3	37	Jan. 2	34½	Feb. 2	34½	Mar. 4	34½	Apr. 4	38
Nov. 3	46	Dec. 4	37	Jan. 3	34½	Feb. 3	34½	Mar. 5	34½	Apr. 5	38
Nov. 4	45½	Dec. 5	37	Jan. 4	34½	Feb. 4	34½	Mar. 6	34½	Apr. 6	38
Nov. 5	45½	Dec. 6	37	Jan. 5	34½	Feb. 5	24½	Mar. 7	34½	Apr. 7	36
Nov. 6	45	Dec. 7	37	Jan. 6	34½	Feb. 6	34½	Mar. 8	34½	Apr. 8	36½
Nov. 7	45	Dec. 8	36½	Jan. 7	34½	Feb. 7	34¼	Mar. 9	34½	Apr. 9	36½
Nov. 8	45	Dec. 9	36½	Jan. 8	34½	Feb. 8	34½	Mar. 10	34½	Apr. 10	38
Nov. 9	45	Dec. 10	36½	Jan. 9	34½	Feb. 9	34½	Mar. 11	34½	Apr. 11	38
Nov. 10	45	Dec. 11	36½	Jan. 10	34½	Feb. 10	34½	Mar. 12	34½	Apr. 12	40
Nov. 11	44	Dec. 12	36½	Jan. 11	34½	Feb. 11	34½	Mar. 13	34½	Apr. 13	40
Nov. 12	43	Dec. 13	36¼	Jan. 12	34½	Feb. 12	34½	Mar. 14	35	Apr. 14	40
Nov. 13	38	Dec. 14	36	Jan. 13	34½	Feb. 13	34½	Mar. 15	35	Apr. 15	41
Nov. 14	37	Dec. 15	36	Jan. 14	34½	Feb. 14	34½	Mar. 16	35	Apr. 16	41
Nov. 15	36	Dec. 16	35½	Jan. 15	34½	Feb. 15	34½	Mar. 17	35½	Apr. 17	41
Nov. 16	36	Dec. 17	35	Jan. 16	34½	Feb. 16	34½	Mar. 18	35½	Apr. 18	41½
Nov. 17	36	Dec. 18	34½	Jan. 17	34½	Feb. 17	34½	Mar. 19	35½	Apr. 19	41½
Nov. 18	36½	Dec. 19	34½	Jan. 18	34½	Feb. 18	34½	Mar. 20	35½	Apr. 20	42
Nov. 19	36½	Dec. 20	34¼	Jan. 19	34½	Feb. 19	34½	Mar. 21	35½	Apr. 21	42
Nov. 20	37	Dec. 21	34¼	Jan. 20	34½	Feb. 20	34½	Mar. 22	36	Apr. 22	42
Nov. 21	37	Dec. 22	34¼	Jan. 21	34½	Feb. 21	34½	Mar. 23	36	Apr. 23	43
Nov. 22	37½	Dec. 23	34¼	Jan. 22	34½	Feb. 22	34½	Mar. 24	36	Apr. 24	43
Nov. 23	37½	Dec. 24	34¼	Jan. 23	34½	Feb. 23	34½	Mar. 25	36	Apr. 25	43½
Nov. 24	37	Dec. 25	34½	Jan. 24	34½	Feb. 24	34½	Mar. 26	36	Apr. 26	43½
Nov. 25	37	Dec. 26	34½	Jan. 25	34½	Feb. 25	34½	Mar. 27	36½	Apr. 27	44
Nov. 26	37	Dec. 27	34½	Jan. 26	34½	Feb. 26	34½	Mar. 28	36½	Apr. 28	44
Nov. 27	37	Dec. 28	34½	Jan. 27	34½	Feb. 27	34½	Mar. 29	36½	Apr. 29	44
Nov. 28	37	Dec. 29	34½	Jan. 28	34½	Feb. 28	34½	Mar. 30	37	Apr. 30	44
Nov. 29	37½	Dec. 30	34½	Jan. 29	34½	Feb. 29	34½	Mar. 31	37½	May 1	44
Nov. 30	37½	Dec. 31	34½	Jan. 30	34½	Mar. 1	34½	Apr. 1	37½		
Dec. 1	37			Jan. 31	34½	Mar. 2	34½	Apr. 2	37½		

XXIV.—REPORT OF OPERATIONS AT THE UNITED STATES SALMON-BREEDING STATION ON THE McCLOUD RIVER, CALIFORNIA, DURING THE YEAR 1883.

By LIVINGSTON STONE.

Nothing of special interest or importance occurred at the salmon-breeding station during the winter and spring of 1883, unless the weather might be considered an exception—for during January and February the weather was unusually clear and cold. Although in the rainy season of 1880–'81 the rainfall amounted to over 9 solid feet of water all over Shasta County and the river rose 26 feet, this season so little rain fell that the river for a considerable time was not above its summer level. This was partly compensated for in March and April by a very heavy rainfall for those months, which raised the McCloud at one time to 8 feet above its summer level. About the middle of May the rain ceased and no more of any consequence fell till the next fall.

During the first part of the year the salmon were observed to come up the river about as usual, but after awhile it was noticed that the number of salmon in the lower portion of the river was rapidly decreasing, and it was also soon after observed that no salmon were coming up the river, as they usually do at that season.

Owing to my having been commissioned to make an exploring trip on the Columbia River, I did not arrive on the McCloud till the 1st of August. I found everything on my arrival in good order. Mr. Radcliff had been engaged for the last month or two in getting the place ready for taking salmon eggs, and everything seemed auspicious for a good season with one exception, which was an important one, to be sure, viz., there were no salmon in the river to amount to anything. The racks and bridge which are annually put across the river above the fishing ground were in place, but no salmon had collected below as had been usual in previous years. We unpacked the new seine, which had just come, and rigged it with floats and leads and ropes, and made a haul with it, going over the ground which we have always been accustomed to at the fishing season. Instead of catching five hundred or a thousand salmon, we caught but one, and that a small one. This was on the 7th of August. The next day, after supper, I went to a point where perhaps a hundred rods of the river could be seen at once, and looked for salmon jumping in the river. Instead of seeing from 6,000 to 8,000 jumping in an hour, as I have often seen before from this

point, I did not see one jump for several minutes. In the meantime all the Indians we met had the same story to tell—that there were no salmon in the river.

This fact was now not only evident, but it implied that some very unusual agencies were at work on a large scale somewhere below us to prevent the salmon ascending the river. On making inquiries, we were told that there were several thousand Chinamen, variously estimated at from 3,000 to 6,000, at work on the California and Oregon Railroad, on the Sacramento River, eight or ten miles below us, and that these Chinamen were doing a very large business in capturing fish by exploding giant powder in the water. As the McCloud flows into Pit River and the Pit into the Sacramento, the abundance of salmon in the McCloud River was, of course, directly affected by this destruction in the Sacramento. So, if the story about the Chinamen was true, this gave one reason why salmon were so scarce in the McCloud.

We also heard that the railroad company were putting in very heavy blasts of powder near the river, and it was possible that this heavy blasting kept the salmon back. Acting upon this information I sent a man to the scene of the blasting operations to make an examination and report on the subject. This man, on his return, stated that the Chinamen did kill what fish they could with giant powder, but he also gave such a description of the blasting operations of the railroad company as led me to think that while the Chinamen were doing some mischief killing salmon with giant powder, the heavy blasting on the railroad was the chief agency in keeping the salmon from ascending the river.*

I immediately telegraphed and wrote to Mr. Joseph D. Redding, the secretary of the California fish commission, apprising him of the state of affairs, and requesting him to use the influence of the State commission as far as possible to remedy the evil.

At Mr. Redding's suggestion the commission sent Mr. Adams to the Chinese camps and the scene of the blasting operations, with directions to make a speedy report on the situation.

Before Mr. Adams had reported, an Indian came to the fishery and said that some men had a rack across the river several miles below here for the purpose of stopping the salmon, and that they were drawing a seine below the rack and selling the salmon to the Chinamen.

The next morning I sent Mr. Radcliff down the river to inquire into the truth of this statement. Mr. Radcliff found some white men preparing a ground for drawing a seine, but did not find any rack or obstruction in the river. He reported also that in his opinion it was the Chinamen that were keeping the salmon back by exploding giant powder in the river, and not the blasting operations of the railroad. I

* I was told on good authority that two six-horse wagon loads of gunpowder (black powder) were put into one hole for a single blast, and that this blasting was kept up night and day as rapidly as the large force of Chinamen employed could prepare and fire off the blasts.

mention this in order to have the case fairly stated, though I am quite confident myself that it was the blasting on the railroad that is mainly responsible for the disturbance of the salmon in the river and their tributaries below the mouth of Pitt River, and I may add that before the season was over this was, I believe, the universal opinion.

While we were waiting for the salmon to come up, and were investigating the reasons for their not coming, I employed the time and the spare means at my disposal in putting up an addition to the hatching house for the purpose of obtaining greater facilities for hatching the young salmon for the river.

The hatching house was barely large enough to hatch 4,000,000 salmon in and keep them till the proper age for turning loose, and as the State fish commission proposed to have 6,000,000 hatched this season, and as many, very likely, in future seasons, it was necessary to provide additional room for the additional 2,000,000 salmon, and for this reason an enlargement of the hatching house had become a necessity. The annex to the hatching house was put up on the south side of the building and was 80 feet long by 8 feet wide, and when finished answered its purpose admirably.

I also attached a small current-wheel to the lower end of the flat-boats, which furnished power for working a Chinese pump in each one of the flat-boats, by which arrangement the boats were kept automatically bailed out. Thus the labor of bailing by hand was saved, to say nothing of the care and risk which were avoided.

The salmon continued as scarce as ever, and there was no improvement seen in their number, during the rest of the season. The result was that we caught fewer salmon and took less eggs this year than ever before since the station was established on the bank of the river in 1873, the total outcome of the season's operation being only 1,000,000 eggs. On the 19th of September an accident happened to the wheel which made it necessary to take the eggs from the hatching house and place them in floating boxes in the river, this operation causing a loss of perhaps 25 per cent of the eggs. A short time after, when there was water enough running in the reserve flume which comes from a spring near the house, the eggs were returned to the hatching house, where they remained till they were turned over to the California fish commission on the 16th of October.

They were afterwards hatched by the State commission and the young fish deposited in the McCloud River.

Following this report will be found—

(1) A record of the hauls made with the seine.

(2) A daily record of the salmon eggs taken.

(3) A record of the temperatures of air and water at the station.

CHARLESTOWN, N. H., *December* 31, 1883.

TABLE I.—*Record of seining (salmon) operations conducted at United States fishery, Baird, Cal., on the McCloud River, from August* 30 *to September* 14, *inclusive*, 1883, *on account of United States, by Livingston Stone.*

Date.	Hour.	Temperature of—		Fish taken.		Ripe fish.	
		Air.	Water.	Males.	Females.	Males.	Females.
		°	°				
August 30	10.00 a. m	......	......	50	25	......	17
August 30	7.45 p. m	59	59	29	2	......	2
August 30	9.00 p. m	59	58	20	3	......	3
August 30	9.45 p. m	59	58	30	1	......	0
August 31	6.00 a. m	58	55	3	......	......	1
August 31	6.30 a. m	58	55	1	0	......	0
August 31	7.15 a. m	58	55	7	2	......	2
August 31	8.15 a. m	62	55	2	1	......	0
August 31	4.30 p. m	72	58	3	0	......	0
August 31	4.40 p. m	71	58	9	0	......	1
August 31	5.40 p. m	70	58	3	3	......	1
August 31	6.00 p. m	70	58	13	3	......	2
August 31	7.15 p. m	66	57	13	2	......	0
August 31	7.45 p. m	65	57	20	3	......	0
August 31	8.15 p. m	64	56	25	2	......	1
August 31	9.15 p. m	64	56	15	3	......	2
August 31	10.00 p. m	64	56	17	4	......	2
September 1	6.00 a. m	58	53	15	......	......	1
September 1	6.30 a. m	58	53	50	......	......	2
September 1	7.45 a. m	65	53	0	......	......	1
September 1	8.30 a. m	67	53	25	1	......	3
September 1	4.30 p. m	86	58	27	......	......	1
September 1	5.00 p. m	80	58	15	1	......	0
September 1	5.45 p. m	73	58	20	......	......	1
September 1	7.00 p. m	66	57	17	......	......	2
September 1	7.15 p. m	65	56	15	2	......	1
September 1	7.45 p. m	62	56	9	0	......	0
September 1	8.15 p. m	60	56	12	1	......	1
September 1	10.00 p. m	55	56	12	1	......	1
September 2	6.00 a. m	......	......	......	3	......	3
September 2	9.35 a. m	66	55	4	2	......	1
September 2	4.35 p. m	76	57	10	3	......	3
September 2	5.05 p. m	72	57	25	0	......	0
September 2	5.35 p. m	70	57	12	0	......	0
September 2	6.35 p. m	70	56	3	......	......	2
September 2	7.20 p. m	70	56	12	0	......	0
September 2	8.20 p. m	68	56	15	1	......	1
September 2	9.25 p. m	68	56	25	1	......	1
September 3	5.15 a. m	54	55	8	2	......	2
September 3	5.35 a. m	54	55	8	2	......	2
September 3	7.20 a. m	64	54	70	......	......	4
September 3	7.40 a. m	64	54	3	......	......	......
September 3	8.30 a. m	74	54	8	......	......	1
September 3	9.30 a. m	80	55	9	0	......	0
September 3	4.30 p. m	94	59	50	8	......	8
September 3	5.00 p. m	92	59	10	1	......	1
September 3	5.15 p. m	88	59	3	0	......	0
September 3	7.00 p. m	......	59	150	5	......	5
September 3	8.00 p. m	66	59	20	5	......	3
September 3	8.45 p. m	64	58	8	2	......	2
September 3	9.50 p. m	58	58	10	4	......	4
September 4	5.00 a. m	54	56	12	5	......	5
September 4	6.00 a. m	56	56	8	2	......	2
September 4	6.30 a. m	58	56	5	1	......	1
September 4	7.30 a. m	64	54	9	0	......	0
September 4	9.00 a. m	76	56	1	2	......	1
September 4	5.00 p. m	98	62	12	3	......	3
September 4	5.40 p. m	96	60	7	1	......	1
September 4	7.10 p. m	94	60	45	4	......	4
September 4	7.25 p. m	94	60	15	1	......	1
September 4	8.00 p. m	91	60	1	1	......	1
September 4	9.00 p. m	92	60	8	......	......	......
September 4	9.45 p. m	92	60	8	1	......	1
September 5	4.30 a. m	54	56	30	5	......	5
September 5	5.10 a. m	52	56	12	1	......	1
September 5	5.35 a. m	52	56	8	3	......	2
September 5	7.15 a. m	56	56	5	4	......	4
September 5	7.35 a. m	58	56	6	2	......	1
September 5	8.00 a. m	62	56	0	0	......	0
September 5	8.20 a. m	64	56	2	0	......	0

TABLE I.—*Record of seining (salmon) operations conducted at United States fishery, Baird, Cal., on the McCloud River, &c.*—Continued.

Date.	Hour.	Temperature of— Air.	Water.	Fish taken. Males.	Females.	Ripe fish. Males.	Females.
		°	°				
September 5	4.25 p. m	92	60	25	6	......	5
September 5	5.00 p. m	86	60	8	0	......	0
September 5	5.40 p. m	80	60	7	2	......	1
September 5	7.10 p. m	68	60	15	1	......	1
September 5	7.30 p. m	66	60	10	1	......	1
September 5	8.10 p. m	64	60	10	1	......	1
September 5	9.00 p. m	60	58	8	0	......	0
September 6	5.45 a. m	48	56	20	5	......	5
September 6	6.15 a. m	50	56	12	1	......	1
September 6	8.00 a. m	62	56	15	6	......	6
September 6	8.25 a. m	70	56	10	2	......	2
September 6	6.35 p. m	78	56	9	1	......	1
September 6	4.10 p. m	90	60	20	7	......	7
September 6	4.35 p. m	90	60	12	2	......	2
September 6	5.10 p. m	82	60	8	3	......	3
September 6	5.50 p. m	74	60	6	1	......	1
September 6	7.10 p. m	68	58	15	3	......	3
September 6	7.30 p. m	66	58	13	2	......	2
September 6	8.30 p. m	62	56	10	1	......	1
September 6	9.15 p. m	60	58	8	0	......	0
September 7	4.45 a. m	48	56	13	5	......	5
September 7	5.10 a. m	48	56	15	7	......	7
September 7	5.45 a. m	48	56	12	1	......	1
September 7	7.20 a. m	52	54	10	1	......	1
September 7	7.30 a. m	53	54	9	2	......	2
September 7	9.25 a. m	71	55	8	1	......	1
September 7	4.23 p. m	88	59	10	1	......	1
September 7	4.49 p. m	87	58	21	......	......	......
September 7	5.16 p. m	82	58	10	1	......	1
September 7	6.00 p. m	75	58	12	......	......	......
September 7	7.10 p. m	69	59	10	1	......	1
September 7	7.48 p. m	67	59	5	......	......	......
September 7	8.55 p. m	64	59	5	......	......	......
September 7	9.25 p. m	61	57	4	1	......	1
September 8	4.55 a. m	49	54	4	5	......	5
September 8	5.15 a. m	49	54	12	4	......	4
September 8	5.45 a. m	48	54	25	8	......	8
September 8	7.55 a. m	55	53	15	8	......	8
September 8	8.15 a. m	60	53	10	1	......	1
September 8	9.30 a. m	76	55	12	3	......	......
September 8	4.35 p. m	86	59	8	3	......	3
September 8	5.09 p. m	79	59	9	0	......	0
September 8	5.50 p. m	76	59	4	1	......	1
September 8	7.35 p. m	68	59	12	1	......	1
September 8	8.30 p. m	60	59	13	2	......	2
September 8	9.45 p. m	58	58	8	1	......	1
September 9	5.00 a. m	50	54	8	2	......	2
September 9	5.30 a. m	49	54	15	5	......	5
September 9	6.05 a. m	48	54	6	1	......	1
September 9	7.15 a. m	50	50	3	0	......	0
September 9	9.10 a. m	87	55	4	......	0	0
September 9	3.50 p. m	87	55	15	......	2	2
September 9	4.55 p. m	91	59	2	......	0	0
September 9	8.55 p. m	70	60	20	......	1	1
September 9	9.00 p. m	65	60	8	......	1	1
September 10	5.00 a. m	54	54	12	......	3	3
September 10	5.35 a. m	50	54	20	......	4	4
September 10	6.15 a. m	50	54	5	......	5	5
September 10	7.40 a. m	55	54	8	......	2	2
September 10	7.58 a. m	56	54	6	......	1	1
September 10	4.35 p. m	90	69	12	......	......	......
September 10	5.35 p. m	81	59	5	......	1	1
September 10	7.01 p. m	73	59	10	......	2	2
September 10	7.30 p. m	73	59	12	......	1	1
September 10	8.40 p. m	67	59	3	......	0	0
September 11	4.30 a. m	56	56	8	......	1	1
September 11	5.15 a. m	53	56	12	......	5	5
September 11	5.50 a. m	51	56	1	......	1	1
September 11	6.00 a. m	51	56	6	......	6	6
September 11	7.40 a. m	59	55	1	......	0	0
September 11	8.15 a. m	60	55	5	......	1	1
September 11	7.25 p. m	70	59	2	......	1	1
September 11	7.00 p. m	76	59	6	......	0	0
September 11	9.15 p. m	61	59	5	......	1	1

TABLE I.—*Record of seining (salmon) operations conducted at United States fishery, Baird, Cal., on the McCloud River, &c.*—Continued.

Date.	Hour.	Temperature of— Air.	Temperature of— Water.	Fish taken. Males.	Fish taken. Females.	Ripe fish. Males.	Ripe fish. Females.
		°	°				
September 12	5.00 a. m	54	54	20	......	11	11
September 12	5.35 a. m	54	54	10	3	......	3
September 12	6.14 a. m	53	54	12	1	......	1
September 12	7.10 a. m	57	54	6	0	......	0
September 12	7.05 a. m	73	59	15	2	......	2
September 12	7.25 a. m	70	59	5	0	......	0
September 12	8.25 a. m	74	59	3	0	......	0
September 12	3.30 p. m	89	55	6	0	......	0
September 13	4.15 a. m	56	54	2	1	......	1
September 13	5.00 a. m	56	54	0	1	......	1
September 13	5.40 a. m	60	54	2	0	......	0
September 13	7.16 a. m	71	54	8	1	......	1
September 13	7.45 a. m	71	54	10	2	......	2
September 13	4.27 p. m	91	59	25	5	......	5
September 13	4.58 p. m	85	59	5	0	......	0
September 13	7.05 p. m	67	59	3	1	......	1
September 13	7.30 p. m	64	59	4	1	......	1
September 13	8.30 p. m	61	59	0	0	......	0
September 14	4.30 a. m	51	54	2	0	......	0
September 14	5.55 a. m	47	52	12	7	......	7
September 14	6.25 a. m	46	52	5	0	......	0
September 14	7.15 a. m	60	54	3	1	......	1
September 14	7.40 a. m	67	54	10	5	......	5
September 14	8.10 a. m	69	54	5	1	......	1
September 14	8.45 a. m	74	54	3	0	......	0
September 14	4.10 p. m	84	58	8	1	......	1
September 14	5.30 p. m	73	58	......	......	......	......
September 14	7.30 p. m	64	58	3	......	1	1
September 14	8.00 p. m	62	58	2	......	0	0
September 14	8.52 p. m	61	58	5	......	1	1
September 15	4.40 a. m	50	54	8	......	4	4
September 15	5.35 a. m	50	54	4	......	0	0
September 15	7.20 a. m	57	54	6	......	1	1
September 15	7.55 a. m	63	54	8	......	1	1
September 15	8.40 a. m	82	54	5	......	0	0

TABLE II.—*Salmon eggs taken at the United States salmon-breeding station, McCloud River, California, during the season of* 1883.

Date.	No. of eggs taken.	No. of salmon spawned.	Date.	No. of eggs taken.	No. of salmon spawned.
August 30	40,000	13	September 11	26,500	9
August 31	19,000	6	September 12	64,500	21
September 1	31,750	9	September 13	22,500	5
September 2	37,500	11	September 14	78,250	21
September 3	44,000	15	September 16	15,750	5
September 4	100,000	27			
September 5	62,500	17	Total	940,750	287
September 6	70,500	24	Add 10 per cent for error in		
September 7	122,000	38	unit of measure	94,075	....
September 8	63,500	20			
September 9	79,500	25	Corrected total	1,034,825	....
September 10	63,000	21			

TABLE III.—*Temperatures of air and water taken at the McCloud River salmon-breeding station, California, from October 7, 1882, to December 31, 1883.*

Date.	7 a. m.		3 p. m.			7 p. m.		Remarks.
	Air.	Water.	Shade.	Sun.	Water.	Air.	Water.	
1882.	°	°	°	°	°	°	°	
Oct. 7......	50	46	68	70	49	58	47	Cleared at 9 a. m.
Oct. 8......	42	46	74	85	49	59	47	Clear.
Oct. 9......	48	46	....	....	....	57	47	Do.
Oct. 10......	52	46	64	69	51	54	50	Rained until noon.
Oct. 11......	....	....	....	....	....	....	....	Do.
Oct. 12......	49	47	64	....	50	62	49	Cloudy.
Oct. 13......	52	48	62	....	52	57	50	Clear.
Oct. 14......	39	47	62	76	49	52	48	Do.
Oct. 15......	42	47	68	83	50	58	49	Do.
Oct. 16......	44	48	70	85	50	59	49	Do.
Oct. 17......	40	47	70	80	50	58	49	Do.
Oct. 18......	49	48	76	90	50	52	49	Do.
Oct. 19......	36	47	76	92	50	50	49	Do.
Oct. 20......	49	47	82	105	50	52	48	Do.
Oct. 21......	48	47	88	98	50	51	49	Do.
Oct. 22......	50	48	86	92	50	52	49	Do.
Oct. 23......	49	48	85	90	49	52	49	Do.
Oct. 24......	48	48	80	89	50	50	49	Do.
Oct. 25......	44	47	82	88	50	56	49	Do.
Oct. 26......	48	48	62	....	49	59	48	Rain.
Oct. 27......	52	47	80	95	50	60	49	Do.
Oct. 28......	52	49	65	....	50	52	49	Cloudy.
Oct. 29......	50	48	70	90	50	50	49	Do.
Oct. 30......	37	47	56	....	48	48	47	Rainy a. m.; cloudy p. m.
Oct. 31......	32	44	51	....	46	46	45	Clear.
Nov. 1......	42	44	50	....	45	47	45	Rain.
Nov. 2......	44	44	46	....	45	47	44	Do.
Nov. 3......	42	44	48	....	45	47	44	Do.
Nov. 4......	48	44	62	82	45	46	44	Clear.
Nov. 5......	49	45	82	90	47	52	46	Do.
Nov. 6......	45	45	78	....	46	50	45	Cloudy.
Nov. 7......	47	45	62	....	46	47	45	Do.
Nov. 8......	49	45	52	....	48	49	47	Rain.
Nov. 9......	47	46	56	....	47	48	46	Clear.
Nov. 10......	45	46	58	78	48	38	47	Do.
Nov. 11......	28	44	48	....	44	32	44	Do.
Nov. 12......	26	43	56	65	44	32	44	Do.
Nov. 13......	26	43	66	82	44	40	43	Do.
Nov. 14......	30	43	66	84	44	42	44	Do.
Nov. 15......	40	44	58	78	45	47	44	Do.
Nov. 16......	40	44	62	82	46	40	43	Do.
Nov. 17......	30	44	62	80	45	42	44	Do.
Nov. 18......	20	42	64	80	44	50	43	Do.
Nov. 19......	26	43	62	76	45	52	44	Do.
Nov. 20......	29	43	64	80	45	....	....	Rain p. m.
Nov. 21......	....	....	....	....	....	....	....	
Nov. 22......	....	....	....	....	....	....	....	
Nov. 23......	28	43	66	88	46	50	44	Clear.
Nov. 24......	42	44	72	90	46	60	45	Do.
Nov. 25......	33	43	70	86	45	60	44	Do.
Nov. 26......	42	44	74	90	45	60	44	Do.
Nov. 27......	40	43	64	82	44	54	44	Do.
Nov. 28......	33	43	72	81	45	58	44	Do.
Nov. 29......	34	43	64	....	45	59	44	Cloudy.
Nov. 30......	42	44	58	....	48	52	46	Rainy.
Dec. 1......	44	45	74	90	48	....	....	Clear.
Dec. 2......	44	44	70	80	45	50	44	Do.
Dec. 3......	43	44	68	78	44	48	44	Do.
Dec. 4......	42	43	68	75	44	50	44	Do.
Dec. 5......	44	43	70	80	44	52	44	Do.
Dec. 6......	40	42	68	78	44	54	44	Do.
Dec. 7......	38	42	60	70	43	48	43	Do.
Dec. 8......	40	42	66	76	43	54	43	Do.
Dec. 9......	48	43	58	58	44	52	44	Rain.
Dec. 10......	50	44	64	68	45	56	45	Do.
Dec. 11......	50	44	62	64	45	60	45	Do.
Dec. 12......	42	44	70	74	44	56	44	Cloudy.
Dec. 13......	40	43	68	76	44	50	45	Clear.
Dec. 14......	38	42	60	66	43	48	43	Do.
Dec. 15......	40	42	62	70	43	46	43	Do.
Dec. 16......	36	42	60	74	43	48	43	Do.
Dec. 17......	34	41	58	68	42	50	43	Cloudy.
Dec. 18......	42	42	64	....	43	54	43	Clear.
Dec. 19......	50	44	52	52	44	52	44	Do.
Dec. 20......	52	44	66	80	45	48	45	Do.
Dec. 21......	44	43	64	76	44	46	44	Do.

TABLE III.—*Temperatures of air and water, &c.*—Continued.

Date.	7 a. m.		3 p. m.			7 p. m.		Remarks.
	Air.	Water.	Shade.	Sun.	Water.	Air.	Water.	
1882.	°	°	°	°	°	°	°	
Dec. 22	40	42	64	80	43	44	42	Clear.
Dec. 23	40	42	58	70	42	48	43	Do.
Dec. 24	38	41	54	....	42	46	42	Do.
Dec. 25	40	41	56	68	41	44	42	Do.
Dec. 26	44	42	60	....	42	50	....	Cloudy.
Dec. 27	38	42	50	....	42	48	44	Do.
Dec. 28	46	43	64	....	44	56	44	Rain.
Dec. 29	40	42	60	70	43	50	43	Cloudy.
Dec. 30	36	42	64	78	43	44	42	Clear.
Dec. 31	30	40	56	60	41	44	42	Do.
1883.								
Jan. 1	52	42	58	82	42	53	42	Clear.
Jan. 2	40	40	56	82	41	40	41	Do.
Jan. 3	30	38	56	76	40	40	39	Do.
Jan. 4	26	38	50	70	40	40	39	Do.
Jan. 5	24	38	54	76	40	40	39	Do.
Jan. 6	24	38	50	68	39	40	38	Do.
Jan. 7	25	38	54	70	39	38	38	Do.
Jan. 8	32	38	60	80	40	44	39	Do.
Jan. 9	34	38	66	84	41	46	39	Do.
Jan. 10	30	40	64	78	41	40	40	Do.
Jan. 11	28	40	60	70	41	36	40	Do.
Jan. 12	24	39	56	68	40	36	40	Do.
Jan. 13	30	38	44	70	40	40	40	Do.
Jan. 14	26	40	44	82	42	50	42	Do.
Jan. 15	27	38	52	62	40	46	41	Do.
Jan. 16	28	38	40	....	39	42	40	Cloudy.
Jan. 17	36	42	46	58	42	36	42	Do.
Jan. 18	23	40	46	60	42	38	41	Clear.
Jan. 19	21	40	44	56	41	38	41	Do.
Jan. 20	25	40	48	56	41	38	40	Do.
Jan. 21	17	37	48	58	40	38	40	Do.
Jan. 22	18	36	50	76	38	40	40	Do.
Jan. 23	20	37	50	75	38	40	40	Do.
Jan. 24	38	40	50	....	40	46	42	Rain.
Jan. 25	36	40	46	....	42	52	42	Do.
Jan. 26	36	42	50	....	44	48	44	Cloudy.
Jan. 27	34	42	50	....	44	46	44	Do.
Jan. 28	36	42	60	70	43	50	43	Do.
Jan. 29	40	40	44	....	42	54	41	Rain.
Jan. 30	30	40	58	68	42	52	41	Clear.
Jan. 31	40	42	62	78	42	48	41	Do.
Feb. 1	30	40	68	82	42	42	41	Do.
Feb. 2	22	38	50	60	40	38	39	Do.
Feb. 3	20	36	60	70	39	34	38	Do.
Feb. 4	21	36	40	52	38	35	38	Do.
Feb. 5	24	38	42	60	38	34	39	Do.
Feb. 6	24	38	38	60	38	36	38	Cloudy.
Feb. 7	22	36	42	42	38	36	38	Clear.
Feb. 8	18	38	50	54	39	40	38	Do.
Feb. 9	24	37	52	56	38	42	38	Do.
Feb. 10	28	38	58	58	38	42	38	Do.
Feb. 11	30	38	44	58	38	36	37	Cloudy.
Feb. 12	38	38	50	....	40	42	41	Rain.
Feb. 13	40	42	40	....	42	46	42	Do.
Feb. 14	36	41	42	....	42	42	42	Do.
Feb. 15	30	42	44	60	42	40	42	Do.
Feb. 16	22	42	44	68	42	42	42	Do.
Feb. 17	22	38	42	68	40	38	40	Do.
Feb. 18	30	40	72	76	42	44	41	Clear.
Feb. 19	40	42	80	90	43	50	43	Do.
Feb. 20	42	42	82	88	43	52	42	Do.
Feb. 21	40	42	76	84	43	52	41	Do.
Feb. 22	38	42	76	84	43	52	42	Do.
Feb. 23	40	40	58	84	42	56	42	Do.
Feb. 24	38	43	66	76	42	50	42	Do.
Feb. 25	32	42	66	76	42	54	42	Do.
Feb. 26	35	42	64	73	42	56	42	Do.
Feb. 27	36	42	70	72	42	56	42	Do.
Feb. 28	36	42	76	84	42	56	42	Do.
Mar. 1	32	42	74	78	46	52	44	Do.
Mar. 2	36	42	76	82	44	58	43	Do.
Mar. 3	34	41	80	88	44	60	43	Do.
Mar. 4	34	41	78	80	44	58	43	Do.
Mar. 5	36	42	80	82	45	59	43	Do.
Mar. 6	40	42	82	84	46	60	44	Do.
Mar. 7	38	42	78	80	44	56	43	Do.

TABLE III.—*Temperatures of air and water, &c.*—Continued.

Date.	7 a. m.		3 p. m.			7 p. m.		Remarks.
	Air.	Water.	Shade.	Sun.	Water.	Air.	Water.	
1883.	°	°	°	°	°	°	°	
Mar. 8	38	42	82	98	46	58	44	Clear.
Mar. 9	40	42	76	82	48	60	46	Do.
Mar. 10	36	42	74	78	48	56	46	Do.
Mar. 11	42	44	74	78	47	62	46	Do.
Mar. 12	38	42	74	78	46	60	45	Do.
Mar. 13	40	42	82	86	46	60	45	Do.
Mar. 14	38	42	82	90	48	56	46	Do.
Mar. 15	36	42	82	94	48	62	46	Do.
Mar. 16	36	44	82	96	48	60	46	Do.
Mar. 17	44	44	84	90	48	64	46	Do.
Mar. 18	36	43	82	94	47	62	46	Do.
Mar. 19	42	44	80	88	48	62	46	Do.
Mar. 20	38	42	86	100	48	66	46	Do.
Mar. 21	36	44	82	90	48	72	46	Do.
Mar. 22	50	44	82	96	48	76	46	Do.
Mar. 23	52	45	60	96	46	50	46	Do.
Mar. 24	44	44	62	....	46	54	45	Cloudy.
Mar. 25	50	46	58	....	46	52	45	Do.
Mar. 26	52	46	54	....	46	54	45	Rain.
Mar. 27	52	44	56	....	46	54	45	Do.
Mar. 28	52	44	52	....	46	54	45	Do.
Mar. 29	42	44	50	....	46	46	45	Do.
Mar. 30	42	44	50	....	46	44	45	Do.
Mar. 31	34	42	50	....	44	44	45	Do.
Apr. 1	42	43	56	....	44	54	44	Cloudy.
Apr. 2	42	43	50	....	44	52	44	Do.
Apr. 3	40	42	60	....	44	50	44	Rain.
Apr. 4	38	42	64	....	43	60	43	Do.
Apr. 5	38	42	70	70	44	58	43	Clear.
Apr. 6	50	44	74	....	44	60	43	Do.
Apr. 7	54	46	56	78	45	52	43	Do.
Apr. 8	52	44	56	....	44	52	43	Rain.
Apr. 9	34	44	62	64	44	50	43	Clear.
Apr. 10	36	42	60	70	43	54	43	Do.
Apr. 11	46	43	54	....	43	46	43	Cloudy.
Apr. 12	30	42	50	70	43	50	43	Do.
Apr. 13	38	42	56	70	43	48	43	Do.
Apr. 14	40	42	52	75	43	52	43	
Apr. 15	46	44	64	80	46	62	45	
Apr. 16	44	43	66	82	46	52	45	Clear.
Apr. 17	38	43	50	84	45	52	45	Do.
Apr. 18	40	44	50	86	45	46	45	Do.
Apr. 19	46	44	48	....	45	56	45	Rain.
Apr. 20	40	44	44	....	45	60	45	Do.
Apr. 21	40	44	46	....	45	52	45	Do.
Apr. 22	40	44	50	84	45	52	45	Clear.
Apr. 23	38	44	46	86	45	54	45	Do.
Apr. 24	38	44	46	86	45	64	45	Do.
Apr. 25	50	45	70	86	46	60	46	Do.
Apr. 26	48	45	72	88	46	62	46	Do.
Apr. 27	46	45	76	90	46	66	46	Do.
Apr. 28	48	46	74	90	47	64	46	Do.
Apr. 29	50	46	76	88	48	55	47	Do.
Apr. 30	60	46	70	89	48	50	47	Do.
May 1	46	50	60	72	52	52	51	Do.
May 2	46	49	66	82	53	56	51	Do.
May 3	50	50	52	....	50	56	51	Cloudy.
May 4	44	50	50	....	50	50	50	Rain.
May 5	42	49	45	....	50	52	50	Do.
May 6	46	48	60	....	50	52	50	Cloudy.
May 7	50	46	62	....	48	52	49	Rain.
May 8	50	48	66	....	49	52	49	Do.
May 9	52	48	70	....	51	64	50	Do.
May 10	60	49	76	84	52	68	51	Clear.
May 11	54	48	60	....	51	60	50	Cloudy.
May 12	42	48	54	....	51	54	50	Rain.
May 13	40	46	50	82	50	55	49	Clear.
May 14	42	46	60	....	48	56	48	Cloudy.
May 15	46	46	52	....	46	52	48	Do.
May 16	50	46	50	....	46	46	48	Rain.
May 17	40	45	60	67	48	52	47	Clear.
May 18	36	45	70	88	48	62	47	Do.
May 19	44	46	86	94	49	63	46	Do.
May 20	56	50	74	86	52	60	51	Do.
May 21	56	50	80	90	52	66	52	Do.
May 22	54	50	66	72	52	52	51	Do.
May 23	48	48	70	75	52	54	52	Do.

TABLE III.—*Temperatures of air and water, &c.*—Continued.

Date.	7 a. m.		3 p. m.			7 p. m.		Remarks.
	Air.	Water.	Shade.	Sun.	Water.	Air.	Water.	
1883.	°	°	°	°	°	°	°	
May 24	52	50	74	80	52	54	52	Clear.
May 25	46	50	70	76	52	54	51	Do.
May 26	50	50	76	84	52	58	51	Do.
May 27	54	50	80	90	53	56	52	Do.
May 28	54	50	82	92	53	56	52	Do.
May 29	50	50	84	96	53	60	52	Do.
May 30	50	50	86	100	53	64	52	Do.
May 31	48	50	80	93	52	60	52	Do.
June 1	50	51	80	98	53	62	52	Do.
June 2	52	51	84	101	53	64	52	Do.
June 3	53	51	86	106	53	66	52	Do.
June 4	53	52	82	100	53	64	53	Do.
June 5	54	52	78	108	53	70	53	Do.
June 6	52	52	78	98	52	60	52	Do.
June 7	52	52	90	100	53	70	52	Do.
June 8	54	52	92	106	53	68	54	Do.
June 9	56	52	94	110	56	72	53	Do.
June 10	55	52	92	104	55	70	54	Do.
June 11	55	52	93	104	55	66	54	Do.
June 12	55	52	94	102	55	66	54	Do.
June 13	56	52	96	100	54	70	53	Do.
June 14	55	52	94	98	54	72	54	Do.
June 15	55	52	90	96	56	74	55	Do.
June 16	56	53	91	100	57	78	56	Do.
June 17	57	53	98	108	57	80	56	Do.
June 18	57	53	98	104	57	80	56	Do.
June 19	56	53	98	103	57	81	56	Do.
June 20	58	54	92	101	58	80	57	Do.
June 21	54	53	96	110	56	82	57	Do.
June 22	56	53	95	106	56	82	57	Do.
June 23	57	53	94	102	56	82	57	Do.
June 24	57	53	98	109	56	80	57	Do.
June 25	58	54	91	112	56	82	57	Do.
June 26	59	54	93	104	56	84	57	Do.
June 27	60	55	100	115	57	90	57	Do.
June 28	58	56	101	111	58	88	56	Do.
June 29	60	56	102	114	59	92	57	Do.
June 30	62	56	104	118	59	94	57	Do.
July 1	62	56	98	104	58	74	57	Do.
July 2	62	56	98	108	58	76	57	Do.
July 3	60	57	100	107	58	80	57	Do.
July 4	62	57	92	100	59	78	58	Do.
July 5	64	56	96	106	60	82	58	Do.
July 6	66	56	98	106	60	77	59	Do.
July 7	70	59	100	112	62	80	60	Do.
July 8	68	59	102	113	62	80	60	Do.
July 9	68	59	102	110	62	84	61	Do.
July 10	66	59	104	111	62	84	61	Do.
July 11	68	59	102	108	62	84	61	Do.
July 12	69	59	100	107	62	80	61	Do.
July 13	69	59	104	118	63	78	62	Do.
July 14	70	60	108	124	63	79	62	Do.
July 15	71	60	106	120	64	85	62	Do.
July 16	69	60	100	118	64	84	63	Do.
July 17	70	60	104	120	64	86	63	Do.
July 18	70	60	106	116	64	84	63	Do.
July 19	68	60	98	108	64	80	63	Do.
July 20	70	60	94	102	66	78	64	Do.
July 21	72	70	99	108	66	80	64	Do.
July 22	70	70	98	106	66	79	64	Do.
July 23	73	70	100	108	66	79	64	Do.
July 24	69	60	100	106	64	75	62	Do.
July 25	70	60	100	110	64	82	62	Do.
July 26	74	60	100	110	64	82	62	Do.
July 27	70	60	98	110	64	84	62	Do.
July 28	68	60	96	110	62	76	62	Do.
July 29	64	59	94	105	60	74	59	Do.
July 30	60	59	96	106	59	74	59	Do.
July 31	58	59	94	100	60	74	59	Do.
Aug. 1	56	59	....	....	....	....	....	Do.
Aug. 2	55	57	96	102	62	80	61	Do.
Aug. 3	56	56	97	101	62	82	61	Do.
Aug. 4	55	56	98	103	62	79	61	Do.
Aug. 5	57	56	97	104	62	84	61	Do.
Aug. 6	56	56	98	110	62	80	61	Do.
Aug. 7	54	56	98	115	62	82	61	Do.
Aug. 8	55	56	97	112	62	80	61	Do.

TABLE III.—*Temperatures of air and water, &c.*—Continued.

Date.	7 a. m.		3 p. m.			7 p. m.		Remarks.
	Air.	Water.	Shade.	Sun.	Water.	Air.	Water.	
1883.	°	°	°	°	°	°	°	
Aug. 9	54	56	94	104	62	80	61	Clear.
Aug. 10	55	56	90	102	62	78	61	Do.
Aug. 11	54	56	85	92	61	78	60	Do.
Aug. 12	54	56	84	91	61	76	60	Do.
Aug. 13	52	55	86	100	61	74	60	Do.
Aug. 14	51	55	87	96	61	76	60	South wind.
Aug. 15	55	55	87	98	61	80	60	Do.
Aug. 16	56	55	93	102	61	80	60	Clear.
Aug. 17	58	56	98	113	62	78	60	Do.
Aug. 18	60	56	97	109	62	79	60	Do.
Aug. 19	56	56	102	115	62	82	62	Do.
Aug. 20	47	56	100	110	62	81	62	Do.
Aug. 21	48	56	98	108	62	79	61	Do.
Aug. 22	47	56	93	100	61	80	60	Do.
Aug. 23	49	55	92	109	60	76	59	Do.
Aug. 24	49	54	97	105	61	78	60	Do.
Aug. 25	48	55	96	107	61	79	60	Do.
Aug. 26	47	55	98	110	59	76	58	Do.
Aug. 27	48	55	98	110	61	78	59	Do.
Aug. 28	50	56	99	113	61	76	60	Do.
Aug. 29	56	56	96	102	60	75	59	Do.
Aug. 30	47	55	90	98	59	75	59	Do.
Aug. 31	58	55	79	88	57	60	57	Slight shower a. m.; partially cloudy p. m.
Sept. 1	49	50	81	101	54	68	52	Clear.
Sept. 2	54	50	78	82	53	68	55	Do.
Sept. 3	60	52	95	102	57	72	56	Do.
Sept. 4	60	53	98	110	59	91	58	Do.
Sept. 5	47	55	91	105	59	68	58	Do.
Sept. 6	46	54	92	108	58	66	57	Do.
Sept. 7	49	54	88	101	58	68	57	Do.
Sept. 8	48	52	89	103	57	65	56	Do.
Sept. 9	48	52	95	115	59	67	57	Do
Sept. 10	50	54	87	104	57	75	57	Do.
Sept. 11	48	54	90	110	59	78	58	Do.
Sept. 12	55	54	90	113	58	76	57	Do.
Sept. 13	56	53	92	112	58	78	57	Do.
Sept. 14	50	52	88	100	56	76	55	Do.
Sept. 15	50	51	81	95	56	66	55	Do.
Sept. 16	48	50	90	105	57	67	56	Do.
Sept. 17	48	52	94	110	58	68	57	Do.
Sept. 18	47	52	92	112	57	78	56	Do.
Sept. 19	52	52	90	110	57	74	56	Do.
Sept. 20	49	52	102	123	57	70	56	Do.
Sept. 21	50	52	104	125	58	72	57	Do.
Sept. 22	59	53	105	126	59	74	58	Do.
Sept. 23	60	54	107	127	58	73	57	Do.
Sept. 24	54	54	100	92	58	75	57	Do.
Sept. 25	52	54	84	....	58	70	57	Cloudy.
Sept. 26	54	50	78	....	52	69	52	Do.
Sept. 27	53	50	80	90	54	70	53	Clear.
Sept. 28	54	50	84	....	54	60	52	Cloudy.
Sept. 29	50	50	58	....	53	56	51	First rain.
Sept. 30	50	50	63	....	53	60	52	Do.
Oct. 1	52	50	64	....	54	58	52	Cloudy.
Oct. 2	42	50	68	80	52	60	50	Clear.
Oct. 3	50	50	70	82	53	62	52	Do.
Oct. 4	54	50	58	....	50	60	50	Cloudy and rain.
Oct. 5	52	50	63	....	52	58	51	Do.
Oct. 6	47	49	63	75	51	58	51	Clear.
Oct. 7	40	49	70	85	52	54	51	Do.
Oct. 9	41	48	80	95	52	56	51	Do.
Oct. 8	40	48	80	100	53	57	52	Do.
Oct. 10	38	49	80	100	54	58	52	Do.
Oct. 11	50	48	78	100	52	67	51	Do.
Oct. 12	42	49	80	100	53	62	52	Do.
Oct. 13	40	49	78	97	52	59	51	Do.
Oct. 14	42	49	72	85	51	58	51	Do.
Oct. 15	39	48	69	80	52	57	50	Do.
Oct. 16	38	48	70	85	51	59	50	Do.
Oct. 17	34	47	70	80	50	58	50	Do.
Oct. 18	38	48	71	87	52	....	....	Do.
Oct. 19	....	....	....	....	....	....	....	Do.
Oct. 20	....	....	....	....	....	....	....	
Oct. 21	....	....	....	....	....	....	....	
Oct. 22	....	....	....	....	....	....	....	
Oct. 23	....	....	....	....	....	....	....	

TABLE III.—*Temperatures of air and water, &c.*—Continued.

Date.	7 a. m.		3 p. m.			7 p. m.		Remarks.
	Air.	Water.	Shade.	Sun.	Water.	Air.	Water.	
1883.	°	°	°	°	°	°	°	
Oct. 24	....	....	....	....	....	....	....	
Oct. 25	....	....	....	....	....	....	....	
Oct. 26	....	....	....	....	....	....	....	
Oct. 27	....	....	....	....	....	....	....	
Oct. 28	....	....	....	....	....	....	....	
Oct. 29	....	....	....	....	....	....	....	
Oct. 30	....	....	....	....	....	....	....	
Oct. 31	....	....	....	....	....	....	....	
Nov. 1	....	....	....	....	....	....	....	
Nov. 2	....	....	....	....	....	....	....	
Nov. 3	....	....	....	....	....	....	....	
Nov. 4	....	....	....	....	....	....	....	
Nov. 5	32	42	....	....	....	....	....	
Nov. 6	38	43	56	....	44	52	44	
Nov. 7	47	45	50	....	44	51	44	Cloudy.
Nov. 8	49	46	52	....	48	52	48	Rain.
Nov. 9	42	46	64	82	48	48	47	Do.
Nov. 10	38	45	68	84	48	50	47	Clear.
Nov. 11	50	46	76	94	48	52	48	Do.
Nov. 12	40	46	72	74	48	52	48	Do.
Nov. 13	43	45	76	82	48	54	48	Do.
Nov. 14	38	44	76	78	48	50	46	Do.
Nov. 15	36	44	78	80	46	48	45	Do.
Nov. 16	40	44	68	72	46	48	40	Do.
Nov. 17	34	44	66	80	46	46	38	Do.
Nov. 18	36	44	....	....	....	44	38	Do.
Nov. 19	36	44	62	80	46	44	38	Do.
Nov. 20	36	44	58	....	44	42	38	Do.
Nov. 21	36	....	64	76	46	44	38	Do.
Nov. 22	36	43	....	....	....	....	38	Do.
Nov. 23	....	....	62	....	46	50	38	Do.
Nov. 24	46	45	52	60	46	46	45	Do.
Nov. 25	28	42	....	....	....	....	....	Do.
Nov. 26	28	41	54	60	42	....	....	Do.
Nov. 27	32	40	64	70	44	44	44	Do.
Nov. 28	38	42	68	82	44	43	44	Do.
Nov. 29	34	42	64	....	....	....	....	Do.
Nov. 30	32	41	64	84	44	....	....	Do.
Dec. 1	33	41	64	70	44	....	....	Do.
Dec. 2	....	....	58	70	44	46	44	Do.
Dec. 3	44	44	58	66	46	44	46	Do.
Dec. 4	32	44	68	82	46	50	46	Do.
Dec. 5	48	44	53	....	45	49	45	Do.
Dec. 6	....	....	61	....	46	48	45	Do.
Dec. 7	48	44	70	86	46	48	45	Do.
Dec. 8	30	....	61	....	44	44	....	Do.
Dec. 9	....	....	....	....	....	....	....	Do.
Dec. 10	32	42	64	70	44	42	....	Do.
Dec. 11	28	....	70	76	44	....	....	Do.
Dec. 12	48	44	76	80	44	50	....	Do.
Dec. 13	48	42	76	94	45	48	45	Do.
Dec. 14	48	43	76	98	45	58	45	Do.
Dec. 15	50	43	80	96	44	....	....	Do.
Dec. 16	....	....	....	....	....	....	....	Do.
Dec. 17	....	....	66	....	44	46	....	Do.
Dec. 18	32	43	....	....	44	46	45	Do.
Dec. 19	38	44	60	....	46	42	....	Do.
Dec. 20	38	44	66	81	46	....	....	Do.
Dec. 21	33	43	....	....	....	....	....	Do.
Dec. 22	28	43	52	80	44	....	....	Do.
Dec. 23	38	44	....	....	....	....	....	Snow.
Dec. 24	43	44	45	....	44	....	....	Do.
Dec. 25	49	45	52	....	45	....	....	Rain.
Dec. 26	53	47	53	....	47	54	47	Do.
Dec. 27	49	46	51	....	48	41	47	Do.
Dec. 28	34	44	45	....	....	43	45	Snow.
Dec. 29	38	44	54	....	....	....	....	Rain.
Dec. 30	43	44	46	....	....	46	45	Do.
Dec. 31	39	43	48	....	45	....	....	Cloudy.

XXV.—REPORT OF OPERATIONS AT THE UNITED STATES TROUT-BREEDING STATION ON THE McCLOUD RIVER, CALIFORNIA, DURING THE YEAR 1883.

By Livingston Stone.

The year opened on the McCloud River with unusually cold and clear weather, in consequence of which both the river and the trout-pond creek were at a very low stage of water. As, however, there is water enough for the trout-ponds, and much to spare even in the hottest and driest time in midsummer, the condition of the creek on this New Year's was by no means unfavorable, but, on the contrary, much more desirable than the opposite state of affairs, which sometimes prevails at this season, when the river is high and the creek is booming and mud is being washed down into the trout-ponds in quantities that are dangerous to the health of the fish.

The trout in the ponds on the 1st of January were in splendid condition. There were between 2,000 and 3,000, and their average weight was about 2½ pounds. They showed signs of spawning earlier this year than in previous years, and on the third day of January the first eggs were taken, to the number of 25,000. The spawning season, although coming several days earlier than in previous years, seemed to have fully set in, because on January 4th 28,000 more eggs were taken, and on the 5th 25,500 were taken.

At the close of the report will be found a table showing the daily number of eggs taken during the season.

This year the spawning of the fish was particularly severe on the men who handled them, owing to the very cold weather that prevailed during the spawning months. This cold weather was unusual even for this locality. It will be remembered, however, that unusual cold weather prevailed over the whole western coast during the winter of 1882–'83, and that at San Francisco the greatest and indeed almost the only snow-storm deserving the name since California was settled occurred during that winter.

When very cold weather is spoken of on the Pacific coast it is not, of course, anything like the extreme cold of the same latitudes on the Atlantic coast that is meant. Indeed, a resident of the Atlantic slope of the United States would be rather amused to hear even the most

frigid winter weather of the Pacific slope described as extremely cold, or even moderately cold. Nevertheless, the nature of the Western cold is such that, although it does not have the contracting effect on inanimate objects—the mercury of the thermometer included—it is often less endurable than the more intense Eastern cold. For example, a person will often suffer more from cold in driving for an hour or two along the coast line near San Francisco in August, when the thermometer hardly stands below 55° F., than one would, with similar clothing, in the interior of New England on a frosty morning with the thermometer thirty degrees lower. In consequence of this peculiarity of the cold weather here, the men who spawned the trout were subjected to a very severe ordeal in performing their task, although the thermometer did not register a greater degree of cold than 20° F.

Mr. Loren Green took most of the eggs this season, and is entitled to much credit for the endurance and perseverance that he exhibited in accomplishing his work. I may add here that Mr. Myron Green, who has had charge of the trout-ponds ever since they were started, resigned his position this summer, owing to his health having become impaired by exposure during the rainy seasons of this climate.

It will be observed by looking at the daily record of eggs taken that there was an interval of two weeks, from January 5 to January 19, when no eggs were taken. This was owing to the very cold weather, which, coming also without rain, seemed to check almost entirely the spawning of the trout. When the weather grew warmer, and particularly when it also rained, the spawning trout came on very rapidly, Mr. Green says, and when it was clear and cold they seemed to have no disposition at all to deposit their eggs. It will also be observed, by looking at the record of the daily yield of eggs, that the spawning season extended over a period of three months, from January 4 to April 4, and that even after April 4 some eggs were taken, which were hatched for the river. This long period of spawning is probably due, I think, to the fact that the creek on which the trout-ponds are built is supplied very largely by springs, it being a well-known fact among trout raisers that the presence of spring water in a stream prolongs the spawning season; and in a large stream, fed wholly by springs, the trout, at least in the eastern waters of the United States, continue their spawning operations several months longer than those in brooks not fed by springs.

Up to the present season no systematic attempt has been made at the McCloud River trout-ponds to rear young trout, the surplus of young fry at the end of each season having been turned into the river, and I may add here that it is very proper, and perhaps indispensable, that a considerable number of young fish should be put into the river each year in order to keep up the river's stock, the yearly draft on the natural supply of trout in the river, caused by our capture of breeding fish for the ponds, being now quite perceptible in its effects.

This year several thousand young fish were reserved in the hatching troughs after all the eggs had been sent off and 20,000 young fry had been turned into the river. These reserved fish were placed in a pond by themselves and the experiment will be tried this year of raising them. It will undoubtedly prove to be only an experiment this season, as all the enemies to the young trout at this place and the difficulties to contend with here in raising them are not yet fully known, but it is hoped that it will be a basis for successful operations in future seasons. Next year, at all events, an elaborate effort will be made to raise a considerable number.

With a view to raising some breeders from the egg, and at the same time to provide more room for those already in stock, new ponds have been built this year, and there is not much doubt that even a larger number would be desirable, for, although the supply of water is very large and of the best quality, it is probable that the breeders are still too closely confined for maintaining perfectly favorable sanitary conditions.

The fishing for parent trout was continued this year, and probably enough were caught to supply this year's waste in the ponds, caused by the various adverse agencies to which trout are exposed, and whose destructive character the trout breeder knows very well.

The fishing was conducted this year on the same general plan as heretofore, viz., by using set-lines stretched from one point to another in the river, and furnished with lateral lines at suitable intervals, to which are attached the hook and bait. These lateral lines extend to the bottom of the river, for unlike eastern trout (*Salvelinus fontinalis*) the McCloud River trout (*Salmo irideus*) feed off the bottom of the stream. Their method of looking for food is peculiar and wholly unlike that of their eastern cousins. Every trout fisherman in the Eastern States has noticed that the speckled *fontinalis* is always looking upwards for food as if expecting, as he really does, that his food will come from above. He is also generally evenly poised in the water and sits in it like a well-trimmed ship on a quiet day at sea. The California trout, on the contrary, roams about his watery hunting grounds partly on his side with one eye directed to the bottom. He is quite as dependent, and probably more so, upon the supply of food that is beneath as for the supply that falls from above or floats on the surface. Consequently he spends as much of his time looking down for food as he does looking up for it. He has another peculiarity also about feeding: When he sees any food on the bottom that looks to him out of place, or has from any cause a suspicious appearance, he wheels past it, and as he passes the suspicious object he strikes it a vigorous blow with his tail and then turns to observe its movements. If there appears to be anything "crooked" about it he will not touch it, and will, after striking it perhaps once or twice more with his tail, abandon it alto-

gether. This we have occasion to notice very often on our fishing grounds, because before setting the lines at any particular spot we "salt" the ground for two or three days before, by freely strewing bait about the place where the lines are to be set. When the trout first come up and see the bait—usually salmon eggs—scattered about so lavishly, in such an unusual place, they seem to suspect at once that there is something wrong about it, and they knock the eggs about vigorously with their tails and watch the bait very cautiously and suspiciously, and it often happens that they will repeat this a day or two before they will decide to swallow this unexpected but tempting food; and Mr. Green assures me that, unless the trout had had their suspicions set at rest by this false and harmless bait, they sometimes could not be persuaded, except with difficulty, to take the real bait in which is concealed the fatal hook.

Much is said about the red-banded trout of these mountain regions, as if they were a distinct variety of trout from the others; and one often hears sportsmen inquire whether they can catch the red-banded trout at a specified place, as if they thought that the trout with the red band were not only different, but much better than the other trout. This is a mistake. The red band is not a mark of a better variety or a different variety, nor, as far as I have been able to learn, a sign of anything in particular except age. It is a badge of maturity and that is all. It is not found on trout less than a year old, but I think I am authorized to say that it is constant or nearly so in very old trout. At all events, the absence of the band is not known to be a sign of anything except youth, for, if you catch a middle-aged trout with the red band, you may catch another feeding by the side of it, of the same variety, age, sex, and of the same size, which does not have the red band. Neither does the band, nor the absence of the band, appear to be a mark of any special season with the fish, for at all seasons of the year, in the spawning season and out of the spawning season, when prime and when not prime, you will find trout with the red band and trout without it side by side and looking otherwise just alike, and this is true of all ages and of both sexes, except, as just remarked, with trout less than a year old, which never have the red band, and with very old trout, which I think always have it. Perhaps it is also safe to say that the older the trout the more likely it is to have the red band and the more pronounced it is likely to be. I may add here that very old trout have other distinguishing marks. Their heads and shoulders are very large compared with the rest of their bodies. Their bodies are not symmetrical, like those of younger fish, but seem to taper almost steadily from the shoulders to the caudal fin. Their mouths will open much wider than those of young trout, and their tails, when stretched, will be less forked; indeed, in very old trout their tails are almost perfectly square, as it is called, by which is meant that the outline of the caudal fin is at the posterior end, when stretched

straight, instead of forked, as it is in young fish. Old fish also have in general a gaunt, ill-favored look, and their flesh is usually a dusky white.

In my last year's report on the trout-ponds, the abundance and proximity of panthers or California lions (*Felis concolor*) was alluded to. One of these, which for several weeks had made himself particularly obnoxious as well as familiar about both the McCloud fishery stations, was shot in the month of September (1882). After the killing of this panther the rest kept away from the settlements to some extent, and we did not see much of them till about midsummer of this year (1883), when they began to come around again. In the latter part of July of this year (1883) Mr. Radcliff came suddenly upon three panthers not far from the fishery on the Copper City trail. Not long after, a large panther crossed the same trail in the daytime, just after Mr. Barber had passed along on horseback, and about the middle of August "Short Jim," one of our Indians, saw a panther in the midst of a herd of cows trying to carry off a calf, but the cows "horned at it" so, to use the Indian's expression, that the panther had to give up the undertaking. Jim had his rifle with him, but said that he could not shoot at the panther without endangering the cows. A day or two after, a panther came down to Mr. Barber's house in the evening, and being chased by his dogs ran about the vicinity for a considerable time and crossed the garden twice with the dogs after him. He cuffed one of the dogs finally, and soon after disappeared. This was peculiar conduct on the part of the panther, for usually when chased by dogs they will almost immediately take to a tree. We have not yet ascertained for a certainty whether the panthers ever have or ever would molest the trout in the trout ponds, though the presumption is that if they thought they could take the trout with safety they would do it, as they will, notwithstanding the cat's proverbial dislike to wetting its feet, frequently get into the water of their own accord, and it is not unusual for them to swim the McCloud River. We think it best, at all events, to be on the lookout for them, as well as for wild-cats, lynxes, coons, minks, otters, and other enemies of living fish, and for the purpose of affording them protection we have two dogs at the trout ponds, one of which is always chained at night between the two principal ponds, and the other near the other ponds. Mr. Green has a partially tame wild-cat, which he thinks he will also keep chained at the ponds for the further protection of the trout.

When this report closed, December 31, 1883, the last accounts from the trout-ponds stated that they were in good condition, that the fish were doing well, and that they were expected to begin spawning in a very few days.

Below will be found a daily record of the number of eggs taken this year, and also a table showing how the eggs were distributed.

CHARLESTOWN, N. H., *December* 31, 1883.

Daily record of trout eggs taken at the McCloud River trout-breeding station of the United States Fish Commission during the season of 1883.

Date.	Number of females spawned.*	Number of eggs taken.	Date.	Number of females spawned.	Number of eggs taken.
January 3	20	25,000	March 9	15	14,000
January 4	25	28,000	March 16	15	15,000
January 5	20	22,500	March 17	5	6,500
January 19	10	13,000	March 18	23	27,000
January 22	22	26,000	March 27	14	16,000
February 5	23	28,000	March 28	15	17,000
February 15	14	17,000	March 29	12	17,000
February 20	15	21,000	March 31	7	10,000
February 21	14	19,000	April 2	15	12,000
February 22	14	14,000	April 5	14	14,000
February 24	12	15,000			
March 7	9	12,000	Total	333	388,000

* Average per fish, 1,165+.

Table of distribution of trout eggs from the McCloud River (California) station of the United States Fish Commission during the season of 1883.

Date.	Consignees.	Destinations.	Number of eggs shipped.
January 25	S. F. Baird	Washington, D. C	50,000
January 26	do	do	21,000
February 12	do	do	12,000
February 15	do	do	24,000
February 26	B. F. Shaw	Anamosa, Iowa	5,000
February 26	William Griffith	Louisville, Ky	5,000
February 26	G. W. Delawder	Druid Hill Hatchery, Baltimore	5,000
February 26	E. A. Brackett	Winchester, Mass	5,000
February 26	C. J. Huske	Columbia, S. C	5,000
March 4	Dr. J. S. Logan	Saint Joseph, Mo	5,000
March 4	George Jelliffe	Westport, Conn	5,000
March 4	C. S. White	Romney, W. Va	5,000
March 7	Dr. E. B. Kennedy	Omaha, Nebr	5,000
March 7	D. Y. Howell	Toledo, Ohio	5,000
March 7	Col. M. McDonald	Smithsonian Institution, D. C	5,000
March 7	George W. Riddle	Plymouth, N. H	5,000
March 9	E. G. Blackford	Fulton Market, New York	30,000
March 13	S. F. Baird	Washington, D. C	14,000
March 27	do	do	24,000
April 5	do	do	45,000
April 13	E. G. Blackford	Fulton Market, New York	15,000
April 14	S. F. Baird	Washington, D. C	37,000
		Deposited in McCloud	20,000
		Deposited in trout-ponds	12,000
		Lost	24,000
		Total	388,000

XXVI.—REPORT ON THE PROPAGATION OF PENOBSCOT SALMON IN 1883-'84.

By Charles G. Atkins.

The work at the Penobscot Station in Bucksport and Orland was conducted in all respects after the methods of former years. The collection of breeding salmon was commenced June 7 (about the usual date) and completed June 30. The total number purchased was 431, of which 28 died in the transporting cars before reaching the inclosure. The salmon were larger than ever before experienced at this station. They averaged 18 pounds in weight. Those taken by other fishermen in all parts of Penobscot River and bay were of similar size, which is entirely unprecedented in the history of the salmon fishery of this river. The salmon purchased by the station averaged 13.04 pounds in 1882; 16.55 pounds in 1881; and 13 pounds in 1880.

During the summer the mortality was unusually great, 133 being found dead, and three more unaccounted for at the end of the season. The original number inclosed having been 403, the percentage of loss was therefore 34. In 1882 it was but 24 per cent.; in 1881 it was 29 per cent., and in 1880 it was but 14 per cent. It will be seen that we have suffered great losses in the years when the salmon were large, and the heaviest loss of all is experienced in the present year when they are the largest ever known. It may be added that it has been a matter of common observation at the Penobscot Station since its inception that the large salmon are much more susceptible to injury from handling than the smaller specimens. However, this does not touch the first cause of the mortality in the inclosure, which it now seems probable, is connected with high water temperature. In support of this view may be mentioned the fact that the deaths in the cars, during transportation, always occur during very warm weather, when the temperature of the surface-water becomes much elevated.

Of the 403 salmon originally impounded, but 267 remained, and came to hand at the breeding season. The crop of eggs would have been a small one had it not been for two circumstances: 1st, the extraordinary size of the fish; and 2d, the unusual proportion of female fish, of which there were 207 out of 403, or 78 per cent., the highest percentage experienced.

The spawning operations occupied from October 29 to November 7.

There were taken 2,535,000 eggs in good condition, an average yield of 12,000 from each female.

Of defective eggs there were taken out at the regular pickings, performed for the most part weekly during their stay in the hatchery, a total of 45,659, and 69,950 unfertilized were discovered by means of concussion and removed just before shipment. The total losses prior to shipment were, therefore, 115,609, or 4.6 per cent. of the original number, leaving for shipment 2,420,000 healthy eggs. A *pro rata* division gave to the United States 1,370,000; to Maine, 700,000; to Massachusetts, 350,000.

The eggs reached the stage for transportation in January, and between January 30 and March 17 they were all dispatched in the usual manner and transported to their destinations with entire success.

The eggs falling to the share of the United States were assigned as follows:

To the Cold Spring Harbor hatchery, New York	500,000
To the Central Station, Washington, D. C	100,000
To the New Hampshire commissioners	100,000
To the Massachusetts commissioners	100,000
To the Maine commissioners	540,000
To Northville, Mich	30,000

The half million assigned to the Cold Spring Harbor hatchery were forwarded in three shipments, and reached their destination with a loss of but 229. The net result of incubation was 448,739 fish, of which 5,000 were retained in a rearing pond, to be planted hereafter (in November, 1884) in some tributary of the Hudson. The bulk of the fry were planted between April 30 and May 27. In Loon Lake, tributary to Schroon River, were placed 40,000; the same number in Tuthill and Beaver Dam brooks, tributary to Salmon River; the remainder, 363,739, were placed in several small streams in Warren County, tributary to the Hudson.

The package of 100,000 eggs addressed to the Central Station was forwarded thence to the Wytheville (Virginia) hatchery, and only 26 were found to be dead on unpacking. The superintendent, Mr. Seagle, said of them: "These eggs are *perfectly faultless*, so far as I can see; much the best lot I have ever received here." The losses during incubation were about 2,000. Of those hatched, 50,000 were planted in Oswego River, New York.

The eggs falling to Massachusetts, together with those assigned by the United States to Massachusetts and New Hampshire, amounting in all to 550,000, were forwarded to the joint hatchery of those States, at Plymouth, N. H. The aggregate losses *en route* were only 153. The incubation was conducted with slight loss, and all the fry planted in June in the Pemigewasset River, a tributary of the Merrimac, in the towns of Compton, Plymouth, Thornton, and Woodstock.

The eggs received by the Maine commissioners, 1,240,000 in number,

were forwarded to four hatching stations within the State: Norway, Weld, Enfield, and Dennysville. Of the 300,000 sent to Norway, but 6 eggs died *en route*. They were hatched with little loss and were planted: 50,000 in the Little Androscoggin, a tributary of the Androscoggin, at Norway, and the remaining 250,000 also in Norway in Crooked River, a tributary of Sebago Lake. Of the 200,000 sent to Weld, 45 died in the packing case, 1,835 in incubation, and 12 in transportation of fry. Of the fry, 75,000 were planted at Weld in Webb's River, a tributary of the Androscoggin, and 123,000 in brooks tributary to Sandy River, a branch of the Kennebec. To Enfield were sent 700,000 eggs, of which 130 died in the packing case. The incubation was conducted without serious loss, and the fry obtained were planted in the Penobscot and tributaries as follows: In the Penobscot, at Medway, 270,000; in the Mattawamkeag, at Bancroft, 85,000; in the Piscataquis, at Dover, 24,000; in the Mattawamkeag, at Island Falls, 24,000; in the mouth of the Piscataquis, at Howland, 70,000; in the Mattawamkeag, at the village of the same name, 215,000. Of the 40,000 sent to Dennysville, only 2 eggs died on the way, 100 died during incubation, and 39,500 were planted in Denny's River in the town of Dennysville.

The lot of 30,000 sent to Northville, Mich., went through with the loss of but 3 eggs on the road. In the course of incubation and development 105 eggs and 632 fish were lost, and 29,260 young fish were planted at the headwaters of Huron River, in Oakland County, Michigan.

XXVII.—REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1883-'84.

By Charles G. Atkins.

The season opened with the promise of an average run of fish. The early spring fishing with hook and line had been very good. The late spring fishing (in June with fly) had been unusually poor, but this was in part attributable to the stage of the lake, which was high and rising all the season. Young salmon were quite plenty; those too small to take a fly were constantly jumping at it. October 27, the date of my arrival on the ground for the work of the spawning season, there appeared to be plenty of fish above the nets. They were often seen jumping, and had at that date already begun to dig the gravel.

The nets were put in position for fishing October 29, and during the following night 113 salmon came in. On the night of the 30th, 50 salmon were taken, and the two succeeding nights yielded 75 each. The males were at first, as usual, in excess, but the relative numbers of the sexes were reversed after the first two nights, and from that time to the close of the season the females were in excess every night. In ordinary seasons, when the aggregate numbers caught of the two sexes are equal, it is customary to infer that we are at the height of the run, and that about half the fish have already come in. This year this conjunction of affairs was reached at the early date of November 4, when only 427 salmon had been captured. I then conceived a hope that this might prove to be an exceptional season, when the females might exceed the males in a much greater ratio than usual. Such proved to be the case. Of the total catch of 1,005, there were 719 females (71 per cent.) and 295 males (29 per cent.). This is a greater disparity than has ever before occurred here.

The fish proved large and prolific. There were 661 gravid females, and they yielded 1,070,500 eggs, an average of 1,623 to each female. This is not quite equal to the yield of the previous season, which was 1,779, but is 98 in excess of that of 1881 (1,525 per fish).

The males averaged 3.2 pounds in weight; the largest one weighed 5.4 pounds, and the smallest (adult) 1.1 pounds. The heaviest female was one of 4.8 pounds, the lightest weighed 1.8 pounds, and the gravid ones averaged 3 pounds. Ovarian disease, which has been mentioned in previous reports as prevalent among the Schoodic salmon, was found

to affect 119 females out of 604 which were examined. This is a percentage of near 20. In 1882 the percentage affected was but 7; in 1881 it is recorded as 17, but I doubt whether the scrutiny of the workmen was as close that year as this. This disease was recognized by defects in the eggs, and may have extended no further. In most cases but a very few eggs were affected.

The eggs were divided between the two hatcheries, those intended for early shipment being placed in No. 3, which is fed by spring water, and the remainder in No. 2, which is fed by lake water. The aggregate losses from the regular pickings up to February 28 were 38,135, and 72,365 unfertilized were removed after concussion. The stock of good eggs was thus reduced to 960,000, of which 240,000 were set aside for the reserve, and 720,000 were available for division among the subscribers.

The following statement shows the details of the division:

Party.	Contribution.	Ratio.	Quota of eggs.
United States	$1,400	$\frac{14}{27}$	373,000
Maine	500	$\frac{5}{27}$	133,500
Massachusetts	500	$\frac{5}{27}$	133,500
New Hampshire	300	$\frac{3}{27}$	80,000
	2,700		720,000

The share of the United States was allotted and forwarded as follows:

Party.	Allotment.	Where sent.
Michigan Commission	10,000	Paris, Mich.
Nebraska Commission	20,000	South Bend, Nebr.
A. R. Fuller, Meacham Lake, N. Y.	2,000	Duane, N. Y.
H. H. Sneed, Chattanooga, Tenn	10,000	Wytheville, Va.
Vermont Commission	10,000	Plymouth, N. H.
Wisconsin Commission	10,000	Madison, Wis.
Sir James Gibson Maitland, Scotland	5,000	Stirling, Scotland.
New Hampshire Commission	40,000	Plymouth, N. H.
Dr. C. H. Barber, Rutland, Vt	5,000	Rutland, Vt.
United States Commission	45,000	Wytheville, Va.
Massachusetts Commission	40,000	Winchester, Mass.
Iowa Commission	10,000	Anamosa, Iowa.
Maryland Commission	5,000	Baltimore, Md.
Cold Spring Harbor Hatchery, New York	40,000	Cold Spring Harbor.
Thomas D. Sayles, Mechanicsville, Conn	10,000	Poquonock, Conn.
Maine Commission	50,000	Enfield and Weld, Me.
California Commission	30,000	Sacramento, Cal.
	342,000	

The number actually shipped to fill these allotments was 346,000. There remained 27,000 of the share falling to the United States Commission that were unassigned. These were retained at the station, hatched with the reserve, and turned into Grand Lake. Those belonging to the States were all transported. The transfer was accomplished in the usual manner between February 25 and March 26, and with entire success. Details will be given below in Table II. The only lot calling for special mention was that shipped to Sir James Maitland, Stirling, Scotland. These eggs were packed as usual for a few days'

journey in wet moss with a protective covering of dry moss, and sent to Mr. Mather in New York, with the expectation that he would unpack them and repack in another manner. They were, however, sent aboard the steamer Baltic without opening. They reached their destination and were unpacked fifteen days and twenty one hours from the time they were packed up at Grand Lake Stream, and, with the exception of bare twenty-five eggs, they were all in perfect condition.

The completion of the incubation of these eggs was generally attended with good success. The exceptions are those sent to Wytheville, Va., and Madison, Wis., and possibly the shipment to Iowa, from which nothing definite has been heard. The Wisconsin lot hatched successfully, but "on about the seventh day after hatching," writes Mr. Nevin, the superintendent, "a white speck began to form on the sack (and, as you know, that is a sure sign of death), and a week after they commenced to die there was not a live fish left in the trough." The death of all those sent to Wytheville also occurred after hatching.

The details of the planting of the young fish so far as they have been received will be found below, in Table III.

TABLE I.—*Fishing record, Grand Lake Stream.*

Date.	Nightly catch.				Summaries.				Temperature of water.	Height of Grand Lake.	
	Males.	Females.	Of doubtful sex.	Total.	Males.	Females.	Of doubtful sex.	Total.		*Ft.*	*Ins.*
1883.											
Oct. 29-30	80	33	....	113	....	....	....	....	47		
30-31	30	20	....	50	....	....	....	....	47	2	1½
Oct. 31-Nov. 1	31	44	....	75	....	....	....	....	46½		
Nov. 1-2	30	45	....	75	171	142	....	313	46½		
2-3	22	37	....	59	193	179	....	372	46		
3-4	17	38	....	55	210	217	....	427	45½		
4-5	14	62	....	76	224	279	....	503	45	2	1½
5-6	11	54	....	65	235	333	....	568	45½		
6-7	4	55	....	59	239	388	....	627	46½		
7-8	15	107	....	122	254	495	....	749	45		
8-9	6	50	....	56	260	545	....	805	44		
9-10	9	33	....	42	269	578	....	847	46	2	2
10-11	3	47	....	49	272	635	....	906	45		
11-12	7	27	....	34	279	662	....	941	45½		
12-13	5	26	....	31	284	688	....	962	41½		
13-14	5	11	....	16	289	690	....	978	38½		
14-15	3	13	1	17	292	712	1	995	37½		
15-16	1	3	....	4	293	715	1	999	36		
16-17	1	1	....	2	294	716	1	1001	35½		
18-19	1	2	....	3	295	718	1	1004	37½		
19-20	0	1	....	1	295	719	1	1005	37½	2	1½

TABLE II.—*Statement of the transfer of Schoodic salmon from Grand Lake Stream in February and March*, 1884.

Date of shipment.	Consignee.	Address.	Final destination.	Number of cases.	Weight.	Number of eggs.			Distance transported.	Time en route.*	Condition on unpacking.	Dead on unpacking.
						Belonging to States.	Belonging to United States.	Total.				
1884.					*Lbs.*				*Miles.*	*Hrs.*		
Feb. 25	U. S. Fish Commission	Washington, D. C	Wytheville, Va	1	117	....	42, 000	42, 000	†1, 150	......	Good	.....
25	G. W. Delawder	Druid Hill Park, Baltimore	Baltimore, Md	1	33	....	5, 000	5, 000	805	......	...do	.....
25	U. S. Fish Commission	Washington, D. C	Washington, D. C	1	33	....	5, 000	5, 000	848	......	...do	.....
25	H. J. Fenton	Windsor, Conn	Poquonock, Conn	1	48	....	10, 500	10, 500	389	80	.. do	22
26	F. Mather	Cold Spring Harbor, New York.	Cold Spring Harbor and Bisby Lake.‡	1	111	....	41, 500	41, 500	640	93	...do	180
26	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	159	52, 000	....	52, 000	389	94	Excellent	50
26	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1	118	41, 500	....	41, 500	508	52	Good; temperature, 42°.	25
27	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	85	33, 000	....	33, 000	389	70	Excellent	30
28	Martin E. O'Brien	South Bend, Nebr	South Bend, Nebr	1	70	....	20, 000	20, 000	1, 925	121	Remarkably good	20
28	B. F. Shaw	Anamosa, Iowa	Anamosa, Iowa	1	47	....	10, 000	10, 000	1, 607	......	....	.....
28	Philo Dunning	Madison, Wis	Madison, Wis	1	49	....	10, 000	10, 000	1, 536	104	Good	4
28	W. D. Marks	Paris, Mich	Paris, Mich	1	48	....	10, 000	10, 000	1, 431	123	.. do	10
Mar. 3	A. R. Fuller	Malone, N. Y	Meacham Lake, New York	1	19	....	2, 000	2, 000	583	265	First class	0
3	Dr. C. H. Barber	Rutland, Vt	Rutland, Vt	1	31	....	5, 000	5, 000	†525	122	Good	1
3	F. Mather	Care E. G. Blackford, Fulton Market, New York.	Stirling, Scotland	1	32	....	5, 000	5, 000	†2, 800	381	...do	25
3	U. S. Fish Commission	Washington, D. C	Wytheville, Va	1	46	....	10, 000	10, 000	1, 150	......	.. do	.....
3	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	221	48, 500	20, 000	68, 500	389	69	Excellent	47
4	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1	198	38, 500	30, 000	68, 500	508	52	Eggs in good condition.	28
4	F. C. Hewey	Rangely, Me	Rangely, Me	1	145	55, 000	....	55, 000	†300	262	Good	50
5	David Masterman	Weld, Me	Weld, Me	1	141	55, 000	....	55, 000	†257	70	...do	150
6	R. H. Buckingham	Sacramento, Cal	Sacramento, Cal	1	97	....	30, 000	30, 000	†3, 700	264	...do	.....
25	A. J. Darling	Enfield, Me	Enfield, Me	1	140	23, 500	30, 000	53, 500	103	46	Good enough	40
26	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	67	....	20, 000	20, 000	389	71	Excellent	13
26	D. Masterman	Weld, Me	Weld, Me	1	66	....	20, 000	20, 000	†257	72	Good	21
26	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1	66	....	20, 000	20, 000	508	93	...do	26
						347, 000	346, 000	693, 000				

* The time is reckoned to the unpacking of the eggs.
† Approximate.
‡ The figures in the table refer to the transfer to Cold Spring Harbor only; 31,000 of the eggs were repacked and sent to Bisby Lake with considerable loss.

TABLE III.—*Statement of the planting of Schoodic salmon fry in 1884.*

State.	Where hatched.	Waters stocked.	Tributary to—	Locality of deposit.	Date of deposit.	Number of fish.
					1884.	
California	Sacramento	Donner Lake		Nevada County	May —	12,000
		Lake Bigler		do	June —	14,000
Connecticut	Poquonock	Readsville Pond	Thames River	Thompson, Windham County	Apr. 22	9,666
Maine	Enfield	Nicatous Lake	Mattawamkeag River	Island Falls, Aroostook County	June —	38,000
		Cold Stream Pond	Penobscot River	Enfield	June —	15,900
	Rangely	Streams leading into Rangely, Mooselucmaguntic and Cupsuptic Lakes.	Androscoggin River	Franklin County, near Rangely	July —	52,000
	Weld	Brooks tributary to Wilton Pond	Sandy and Kennebec Rivers	Wilton, Franklin County	June —	5,000
		Brooks tributary to Weld Pond	Swift and Androscoggin Rivers	Weld, Franklin County	June —	65,000
	Grand Lake Stream	Grand Lake	Schoodic and Saint Croix Rivers	Hinkley, Washington County	June —	261,704
Maryland	Baltimore	Returns deficient	Returns deficient	Garrett County		3,900
Massachusetts*	Winchester	do	do	Returns deficient		Returns deficient.
Michigan	Paris	Torch Lake	Rapid River	Kalkaska, Kalkaska County	June 6	9,739
Nebraska	South Bend	Spring Brook	Running Water River	Fort Niobrara	Apr. 11	4,950
New Hampshire	Plymouth	Newfound Lake	Pemigewasset River	Hebron, Grafton County	June 7	10,000
		Squam Lake	do	Holderness, Grafton County	June 9	10,000
		Sunapee Lake	Merrimac River	Newbury, Sullivan County	June 16	10,000
		Pleasant Pond	do	Deerfield	June 14	5,000
		Tarlton Lake	Connecticut River	Piermont, Grafton County	June 17	5,000
		Webster Lake	Merrimac River	Franklin	June 19	5,000
		Pratt's Pond	do	New Ipswich	June 19	5,000
		Policy Pond	do	Derry	June 19	5,000
		North Pond	do	Harrisville	June 20	5,000
		Humphrey's Pond	Connecticut River	Winchester	June 20	5,000
		Umbagog Lake	Androscoggin River	Cambridge	June 23	10,000
		Dan's Hole Pond	Saco River	Tuftonboro'	June 28	15,000
		Echo Lake	Connecticut Lake	Franconia	June 28	5,000
		Massabesic Lake	Merrimac River	Manchester	June 30	5,000
New York	Bisby Lake	Woodhull Lake	Black River	Wilmurt, Herkimer County	May 20	10,000
Vermont	Rutland	Spring Lake (= Shrewsbury Pond)	Otter Creek and Lake Champlain	Shrewsbury, Rutland County	June 1	4,700
	Plymouth, N. H	No returns				

* From the Massachusetts commissioners I have received the following statement: "Distribution of Schoodic salmon from hatching-house, Winchester, Mass., for the great ponds throughout the State, delivered during the last of May and first of June, 1884, as follows: Thomas Lawrence, Falmouth, 6 cans; Hon. Charles G. Reed, Worcester, 7 cans; J. B. Hull, Stockbridge, 3 cans; H. R. Boyden, Sharon, 2 cans; C. E. Peck, Wilbraham, 2 cans; M. Gifford, Falmouth (Waquoit), 4 cans; J. T. Hinds, Webster, 2 cans; E. S. Thayer, Salem, 3 cans; W. A. Bullard, Natick, 6 cans; A. H. Manning, Pittsfield, 3 cans; E. Howes, Gloucester, 2 cans; S. P. Keyes, New Marlboro', 4 cans; J. O. Parker, Methuen, 2 cans; Spencer Water Company, Spencer, 2 cans; B. P. Chadwick, Bradford, 1 can; H. H. Wyman, Winchendon, 4 cans; C. E. Gould, Leominster, 2 cans; Moses Palmer, Groton, 1 can. The remainder, together with the 20,000 (really 40,000) donated by the U S. Commission, were put into Mystic Pond, in Winchester and Medford."

XXVIII.—REPORT OF OPERATIONS AT CENTRAL STATION, UNITED STATES FISH COMMISSION, DURING 1883.

By Marshall McDonald.

1. General considerations.

The central station of the U. S. Fish Commission is more complex in its organization and characterized by greater diversity in its operations than any other station of the commission.

a. It is a depot of the property of the Commission and of the property and collections of the U. S. National Museum. The care and preservation of these, and of the buildings and grounds, requires a storekeeper, a watchman, and one or more laborers.

b. It is the center of distribution for carp, tench, and other species of fish bred at the ponds of the U. S. Fish Commission in Washington; and the larger proportion of shad which are sent out each season are hatched at and distributed from Central Station.

c. It is the principal station of the Commission for the propagation of shad; from twelve to twenty millions of this species being hatched each season from eggs collected from the fishing shores and gill-net fishermen on the Potomac River.

Considerable numbers of whitefish, lake trout, and various other species of Salmonidæ are hatched out at the station each winter, and distributed to suitable waters conveniently reached from the station.

This division of the work involves the employment of a superintendent of propagation permanently, and from time to time such assistants as the emergencies of the work may render necessary.

d. It is a station for the conduct of biological and experimental investigations relating to fish-culture. The materials for such researches are gathered and held here, and the station being in immediate proximity to the National Museum, it affords to students of natural history an admirable field for the study of the life history of those species which are interesting either on account of their economic importance, or are in essential relations to them. The series of aquariums containing living specimens of many of our freshwater species of fish, and the illustrations of the methods and apparatus of modern fish-culture to be found at the station, are objects of absorbing interest to visitors, and the pro-

posed extension of the system by the addition of interesting forms of life which belong to salt water will render this feature of the station most valuable as a means of engaging public attention, awakening public interest, and communicating instruction in natural history.

2. The personnel of the station.

This consists of a superintendent of the station, a superintendent of fish-culture, a storekeeper, and such assistants, watchmen, laborers, &c., as the exigencies of the work from time to time require.

3. Improvements and alterations.

During 1883 the following changes were made:

a. That portion of the lower or basement floor heretofore occupied by Mr. Horan was vacated, and the interior reconstructed and arranged with reference to the greater convenience of the work of propagation and distribution.

b. The roadways and footways in the interior of the inclosure were concreted and asphalted, the interspaces sodded, and a substantial retaining wall of brick, with heavy stone coping, built along the line of the B street siding.

c. The hatching-jars improvised for the shad work of 1882 were substituted by the perfected jars, which were designed for but not completed in time for the work of 1882.

d. Six collecting aquariums of plate-glass sides and ends, and slate frames, each having a storage capacity of one-half million shad fry, were added to and completed the equipment of the fish-cultural division of the station.

4. Current work of the station.

Propagation of shad.—The eggs hatched at Central Station during the season were obtained exclusively from the Potomac River. The eggs collected from the gillers and from the fishing shores were concentrated at Fort Washington, whence they were shipped to Central Station either by the steamer W. W. Corcoran or by the steam yacht Lookout. In emergencies shipments were made by the Herreshoff launch attached to the Fort Washington Station. The work of collecting and forwarding the eggs was under the direction of W. C. Babcock, U. S. N., with James Carswell as executive officer in immediate charge of the details of the work. The total number of eggs forwarded from the Fort Washington station was 24,275,000, which, after being freed from shells, and from unimpregnated and water-hard eggs, amounted to 17,761,500, and yielded for distribution 470,000 eggs and 12,128,500 fry. The percentage of loss in forwarding and hatching was exceptionally great, and is to be attributed to several causes, namely:

(*a*) Carelessness in handling the eggs resulting in imperfect impregnation.

(*b*) The forwarding of unimpregnated water-hard eggs under the impression that they were impregnated.

(*c*) The low temperatures of water prevailing during the season, which made impregnation very difficult in the hands of unskilful or careless spawn-takers.

The following summary (Table I) shows the sources from which the eggs were obtained, and the quality of the eggs in each case, as indicated by the percentage of loss in transportation and hatching.

TABLE I.—*Summary of shad eggs received at Central Station, season of* 1883.

Whence obtained.	Number of eggs received from collecting stations.	Number of eggs received alive.	Percentage of eggs alive on arrival.	Number of eggs reshipped.	Number of eggs which produced fish.	Number of eggs lost in course of hatching.	Percentage of eggs shipped which produced fish.	Percentage of eggs received alive which produced fish.
Moxley's Point	7,518,500	5,420,500	72	220,000	3,648,500	1,552,000	48	67.4
Gillers	5,818,000	4,224,500	72	120,000	3,092,000	1,012,500	53	73.2
White House	5,315,000	4,175,000	78	80,000	2,998,000	1,097,000	56	71.8
Ferry Landing	3,312,000	2,425,000	73	50,000	1,370,000	1,005,000	41	56.9
Chapman's Point	1,097,000	620,000	56	....	391,000	229,000	35	61.4
Fort Washington	1,089,500	851,500	78	....	592,000	259,500	54	69.5
——— (not stated)	125,000	45,000	36	....	37,000	8,000	29	82.2
Total	24,275,000	17,761,500	66$\frac{3}{7}$	470,000	12,128,500	5,163,000	45$\frac{1}{2}$	68.9

Table II furnishes as complete a history of each lot of eggs received at the station as it was practicable to obtain, but some of the records lack the precision necessary to furnish the data for satisfactory conclusions. It is evident, from the table, that in general the period of incubation varies inversely to the temperature prevailing during the incubation. But we cannot disguise the fact that there are other influences not well understood which accelerate or retard development under precisely the same conditions of temperature. We know, for example, that strong light, whether direct or diffused, will accelerate development; again we know that continuous dark and cloudy days will retard development under precisely the same conditions of water temperature. It is possible, too, that the rate of development may be in a measure determined by the initial temperature, or that prevailing at the time of impregnation. It will require careful observations for several seasons to obtain the data necessary to discuss the conditions influencing development, and Table II is published here in order to put on record, in convenient form for reference, such data bearing on the question of development as have been accumulated.

TABLE II.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1883.

No. of record card.	Eggs taken. Date.	Eggs taken. Hour of day.	Eggs received. Date.	Eggs received. Hour of day.	Whence obtained.	By whom taken.	Total number received.	Number received alive.	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching. Began. Date.	Period of hatching. Began. Hour of day.	Period of hatching. Ended. Date.	Period of hatching. Ended. Hour of day.	Temperature during incubation. Max.	Temperature during incubation. Min.	Temperature during incubation. Av.	Days and hours in incubating.
		h. m.		h. m.								h. m.		h. m.				d. h.
1	Apr. 14	9	Apr. 14	17	Fort Washington		25,000	12,500	10,000	III 31	Apr. 22	8	Apr. 26	8	57	50	55¼	11 23
2	Apr. 14	16	Apr. 15	16	Moxley's Point		40,000	25,000	20,000	III 32	Apr. 23	8	Apr. 27	8	57	54	55⅔	12 16
3	Apr. 15	20	Apr. 16	16	...do		100,000	62,000	34,000	III 17	Apr. 23	11	Apr. 28	19	57	54	55¾	12 23
4	Apr. 15	20	Apr. 16	16	...do		100,000	65,000	50,000	III 29	Apr. 24	9	Apr. 29	19	57	54	55¾	13 23
5	Apr. 15	20	Apr. 16	16	...do		100,000	60,000	33,000	III 28	Apr. 23	11	Apr. 28	19	57	54	55¾	12 23
6	Apr. 16	19	Apr. 17	16	...do		70,000	42,500	33,500	III 18	Apr. 23	11	Apr. 28	9	57	54	55¾	11 14
7	Apr. 16	19	Apr. 17	16	...do		70,000	40,000	32,000	III 30	Apr. 23	11	Apr. 28	9	57	54	55¾	11 14
8	Apr. 17	18	Apr. 18	16	...do	Luckett & Manning	112,000	99,000	45,000	III 24	Apr. 26	8	May 1	10	57	54	55¾	13 16
9	Apr. 17	18	Apr. 18	16	...do	...do	110,000	96,000	45,000	III 23	Apr. 26	8	Apr. 30	7	57	54	55¾	12 13
10	Apr. 17	18	Apr. 18	16	Fort Washington	Johnson & Carswell	90,000	72,500	26,000	III 21	Apr. 25	13 45	Apr. 29	13	57	54	55¾	11 19
11	Apr. 17	18	Apr. 18	16	...do	...do	97,500	75,000	27,000	III 22	Apr. 25	13 45	Apr. 29	13	57	54	55¾	11 19
12	Apr. 17	18	Apr. 18	16	Gillers	...do	105,000	75,000	30,000	III 20	Apr. 26	7	Apr. 30	14	57	54	55¾	12 20
13	Apr. 18	21	Apr. 19	16	Moxley's Point	Luckett & Langley	37,000	15,000	9,000	III 26	Apr. 26	9 15	Apr. 30	16 15	57	54	55¾	11 19¼
14	Apr. 18	22	Apr. 19	16	Fort Washington	Johnson & Manning	55,000	30,000	19,000	III 27	Apr. 26	9 15	Apr. 30	16 15	57	54	55¾	11 18¼
15	Apr. 19	21	Apr. 20	17	Moxley's Point	Luckett & Langley	82,500	45,000	12,000	III 25	Apr. 28	6	Apr. 30	14	57	54	55¾	10 17
16	Apr. 19	21	Apr. 20	17	...do	...do	82,500	53,000	20,000	III 19	Apr. 28	7	Apr. 30	14	57	54	55¾	10 17
17	Apr. 19	21	Apr. 20	17	...do	...do	100,000	60,000	30,000	III 18	Apr. 28	11	Apr. 30	18	57	54	55¾	10 21
18	Apr. 19	21	Apr. 20	17	...do	...do	82,500	60,000	30,000	III 17	Apr. 28	11	May 2	21	57	54	55¾	13 00
19	Apr. 19	18	Apr. 20	17	Gillers	Skinner	52,000	15,000	4,000	III 26	Apr. 28	6	Apr. 30	14	57	54	55¾	10 20
20	Apr. 20	22	Apr. 21	17	Moxley's Point	Luckett & Langley	84,000	10,000	5,000	III 3	Apr. 30	8	May 4	12	59	54	55¾	13 14
21	Apr. 20	22	Apr. 21	17	...do	...do	110,000	35,000	None.									
22	Apr. 20	19	Apr. 21	17	Gillers	Skinner	105,000	45,000	9,000	III 4	Apr. 30	8 15	May 3	21	58	54	55	13 2
23	Apr. 21	12	Apr. 21	17	Fort Washington	Luckett	65,000	50,000	11,000	III 5	Apr. 30	8 15	Apr. 30	21	57	54	55½	9 9
24	Apr. 21	9	Apr. 21	17	Moxley's Point	Skinner	90,000	50,000	21,000	III 2	Apr. 30	8	May 4	12	59	54	55¾	13 3
25	Apr. 21	20	Apr. 22	17 30	Gillers	...do	125,000	95,000	40,000	III 17	Apr. 30	7 30	May 3	12	58	54	55	11 16
26	Apr. 21	19	Apr. 22	17 30	Chapman's Point	Johnson & Manning	80,000	67,000	41,000	III 21	Apr. 30	16 15	May 3	19	58	54	56	12 00
27	Apr. 21	23	Apr. 22	17 30	Moxley's Point	Luckett & Langley	50,000	10,000	9,000	III 25	May 1	9	May 2	23	57	54	55½	11 1
28	Apr. 23	19	Apr. 24	16	White House	Johnson & Skinner	130,000	70,000	None.									
29	Apr. 26	17 30	Apr. 27	16 10	Chapman's Point	Johnson & Manning	48,000	40,000	15,000	III 3	May 4	10	May 4	18	59	55	56½	8 0½
30	Apr. 27	20	Apr. 28	16	Ferry Landing		15,000	None.										
31	Apr. 28	18	Apr. 29	16	Chapman's Point	Johnson & Keese	40,000	None.										
32	Apr. 29	18	Apr. 30	16 15	White House	Jones & Skinner	90,000	68,000	18,000	III 31	May 6	7	May 8	13	62	55	58½	8 19
33	Apr. 30	19	May 1	15 45	Chapman's Point	Johnson & Manning	35,000	20,000	None.	III 30								
34	May 1	18	May 2	16 30	Moxley's Point	Luckett & Langley	65,000	30,000	None.	III 26								
35	May 1	18	May 2	16 30	Gillers	Wesley	47,000	18,000	None.	III 26								
36	May 1	22	May 2	16 30	Ferry Landing	Richard Faunce	75,000	50,000	15,000	III 28	May 9	6	May 10	15	65	56	60	8 17

37	May 1	14	May 2	16 30	White House	Jones & Skinner	65,000	43,000	35,000	III	29	May 9	6	May 11	15 30	66	56	60	10 $1\frac{1}{2}$
38	May 1	19	May 2	16 30	Chapman's Point	Johnson & Manning	82,000	68,000	60,000	III	27	May 7	15 30	May 10	15	65	56	60	8 20
39	May 2	19	May 3	16	...do	...do	80,000	45,000	24,000	IV	2	May 8	9 30	May 12	7	67	58	$62\frac{1}{2}$	9 12
40	May 2	19	May 3	16	...do	...do	80,000	40,000	21,000	IV	3	May 8	9 30	May 12	7	67	58	$62\frac{1}{2}$	9 13
41	May 2	18	May 3	16	White House	Jones & Skinner	75,000	60,000	50,000	IV	4	May 8	9	May 12	14	67	58	$62\frac{1}{2}$	9 20
42	May 2	18	May 3	16	...do	...do	70,000	35,000	25,000	IV	5	May 8	9	May 12	14	67	58	$62\frac{1}{2}$	9 20
	May 2	18	May 3	16	Moxley's Point	Luckett & Langley	60,000	None.		IV	11								
43	May 2	18	May 3	16	...do	...do	75,000	5,000	4,000	IV	12	May 9	6	May 11	8	66	58	$61\frac{6}{7}$	8 14
44	May 2	20	May 3	16	Ferry Landing	Richard Faunce	80,000	45,000	32,000	IV	9	May 9	6	May 11	8	66	58	$61\frac{6}{7}$	8 12
45	May 2	20	May 3	16	...do	...do	65,000	35,000	24,000	IV	10	May 9	6	May 11	8	66	58	$61\frac{6}{7}$	8 12
46	May –		May 3	16			60,000	15,000	13,000	IV	7	May 8	11	May 12	13	67	58	$61\frac{6}{7}$	
47	May –		May 3	16			65,000	30,000	24,000	IV	8	May 8	11	May 12	13	67	58	$61\frac{6}{7}$	
48	May 3	7	May 3	16	Ferry Land'g giller		65,000	15,000	None.	IV	6								
	May 3	22	May 4	16	White House	Jones & Skinner	75,000	None.											
49	May 3	22	May 4	16	...do	...do	82,000	20,000	34,000	IV	16	May 9	6	May 12	16	67	59	$63\frac{1}{4}$	8 18
50	May 4	12	May 4	16	Fort Washington giller.		55,000	38,000	18,000	IV	25	May 9	15 45	May 12	13	67	59	$63\frac{1}{4}$	8 1
51	May 3	19	May 4	16	Chapman's Point	Luckett & Langley	40,000	25,000	23,000	IV	24	May 9	15 45	May 12	23	67	59	$63\frac{1}{4}$	9 4
52	May 3	20	May 4	16	Moxley's Point	Johnson & Langley	105,000	85,000	50,000	IV	8	May 9	15	May 13	8	67	59	$63\frac{1}{4}$	9 12
53	May 3	20	May 4	16	...do	...do	82,000	37,000	33,000	IV	32	May 9	6	May 12	16	67	59	$63\frac{1}{4}$	8 20
54	May 3	20	May 4	16	...do	...do	90,000	40,000	33,000	IV	31	May 10	7	May 12	13 30	67	59	$63\frac{1}{4}$	8 $15\frac{1}{2}$
55	May 3	20	May 4	16	...do	...do	90,000	52,000	45,000	IV	13	May 9	6	May 12	13	67	59	$63\frac{1}{4}$	8 17
56	May 3	20	May 4	16	...do	...do	75,000	37,000	32,000	IV	14	May 9	6	May 12	13	67	59	$63\frac{1}{4}$	8 17
57	May 3	22	May 4	16	...do	...do	75,000	35,000	21,000	IV	11	May 9	6	May 11	10	66	59	$62\frac{6}{7}$	7 12
58	May 3	22	May 4	16	...do	...do	82,000	30,000	19,000	IV	12	May 9	6	May 11	10	66	59	$62\frac{6}{7}$	7 12
59	May 4	20	May 5	16	...do	Langley & Keese	70,000	30,000	30,000	IV	16	May 10	8	May 11	8	66	60	$62\frac{6}{7}$	6 12
	May 4	20	May 5	16	...do	...do	75,000	None											
60	May 4	20	May 5	16	...do	...do	70,000	20,000	12,000	IV	22	May 10	6	May 12	13	67	60	$63\frac{1}{3}$	7 17
61	May 4	20	May 5	16	...do	...do	85,000	37,000	35,000	IV	21	May 10	6	May 12	13	67	60	$63\frac{1}{3}$	7 17
62a	May 4	23	May 5	16	Fort Washington		25,000	12,500	8,000	IV	5	May 10	6	May 11	11	66	60	63	6 12
62b	May 4	23	May 5	16	Gillers		25,000	12,500	8,000	IV	5	May 10	6	May 11	11	66	60	63	6 12
	May 4	18	May 5	16	Chapman's Point	Luckett & Manning	60,000	None.											
	May 4	18	May 5	16	...do	...do	60,000	None.											
63	May 4	18	May 5	16	...do	...do	120,000	15,000	12,000	IV	6	May 10	6	May 11	23	66	60	63	7 5
64	May 4	17	May 5	16	White House	Jones & Skinner	56,000	5,000	None.										
65	May 4	17	May 5	16	...do	...do	50,000	5,000	None.										
	May 4	17	May 5	16	...do	...do	50,000	None.											
	May 4	17	May 5	16	...do	...do	60,000	None.											
66	May 5	14	May 5	16	Fort Washington giller.		35,000	30,000	27,000	IV	3	May 10	15	May 12	16	67	60	$63\frac{1}{3}$	7 2
67	May 5	11	May 6	16	Ferry Landing	Richard Faunce	92,000	70,000	45,000	IV	26	May 11	15	May 13	16 30	67	61	$64\frac{1}{3}$	8 $5\frac{1}{2}$
68	May 5	18	May 6	16	White House	Jones & Skinner	92,000	40,000	30,000	IV	30	May 11	8	May 13	8	67	61	64	7 14
69	May 5	14	May 6	16	Chapman's Point	Luckett & Manning	90,000	75,000	60,000	IV	14	May 10	6	May 13	3	67	61	64	7 13
70	May 5	14	May 6	16	...do	...do	90,000	60,000	45,000	IV	15	May 10	7	May 13	8	67	61	64	7 18
71	May 5	11	May 6	16	Gillers		32,000	15,000	8,000	IV	23	May 10	7	May 13	8	67	61	64	7 21
72	May 5	11	May 6	16	Ferry Landing	Richard Faunce	95,000	40,000	25,000	IV	23	May 10	9	May 13	8	67	61	64	7 21
73	May 6	12	May 7	16	...do		112,000	55,000	30,000	IV	10			May 13	16	67	61	65	7 4
74	May 6	12	May 7	16	...do		90,000	50,000	25,000	IV	12	May 11	10	May 13	23	67	61	65	7 11
75	May 6	18	May 7	16	Fort Washington giller.		65,000	40,000	35,000	IV	18	May 10	9	May 14	10	67	61	65	7 16
76	May 6	18	May 7	16	...do		65,000	45,000	35,000	IV	17	May 10	9	May 14	10	67	61	65	7 16
77	May 6	16	May 7	16	White House		85,000	65,000	50,000	IV	20	May 11	9 15	May 14	14	67	61	65	7 22

TABLE II.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1883—Continued.

No. of record card.	Eggs taken. Date.	Eggs taken. Hour of day.	Eggs received. Date.	Eggs received. Hour of day.	Whence obtained.	By whom taken.	Total number received.	Number received alive.	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching. Began. Date.	Began. Hour of day.	Ended. Date.	Ended. Hour of day.	Temperature during incubation. Max.	Min.	Av.	Days and hours in incubating.
		h. m.		h. m.								h. m.		h. m.				d. h.
78	May 6	16	May 7	16	White House	....	90,000	70,000	50,000	IV 19	May 10	9	May 14	13	67	61	65	7 21
79	May 6	16	May 7	16	....do	....	90,000	60,000	44,000	VI 3	May 11	7	May 14	11	67	61	65	7 19
80	May 6	16	May 7	16	....do	....	90,000	70,000	45,000	VI 5	May 11	10	May 14	20	67	61	65	8 4
81	May 6	23	May 7	16	Moxley's Point	....	82,000	70,000	50,000	VI 6	May 11	10	May 15	9	67	61	65 2/7	8 10
82	May 6	23	May 7	16	....do	....	90,000	75,000	45,000	VI 7	May 11	10	May 15	9	67	61	65 2/7	8 10
83	May 6	23	May 7	16	....do	....	90,000	75,000	55,000	VI 1	May 11	7	May 15	11	67	61	65 2/7	8 12
84	May 6	23	May 7	16	....do	....	92,000	80,000	56,000	VI 2	May 11	7	May 14	13	67	61	65	7 14
85	May 7	......	May 7	23 30	Chapman's Point	....	95,000	80,000	30,000	VI 8	May 11	10	May 14	13	67	62	65	......
86	May 7	......	May 7	23 30	....do	....	97,000	85,000	60,000	VI 9	May 11	11 30	May 14	13	67	62	65	......
87	May 7	......	May 7	23 30	White House	....	105,000	97,000	45,000	VI 10	May 11	10	May 15	9	67	62	65	......
88	May 7	......	May 7	23 30	....do	....	90,000	80,000	50,000	VI 11	May 11	10	May 15	11	67	62	65	......
89	May 7	......	May 7	23 30	....do	....	112,000	100,000	65,000	VI 12	May 11	10	May 14	20	67	62	65	......
90	May 7	......	May 7	23 30	....do	....	120,000	97,000	65,000	VI 13	May 11	10	May 15	9	67	62	65	......
	May 7	22 30	May 8	16	Moxley's Point	....	35,000	None.	......	......	......	......	......	......	......	......	......	......
	May 7	14	May 8	16	Ferry Landing	....	80,000	None.	......	......	......	......	......	......	......	......	......	......
	May 7	14	May 8	16	....do	....	105,000	None.	......	......	......	......	......	......	......	......	......	......
91	May 8	16	May 8	20 30	....do	....	120,000	75,000	None.	VI 30	......	......	......	......	......	......	......	......
92	May 8	16	May 8	20 30	....do	....	93,000	70,000	None.	VI 31	......	......	......	......	......	......	......	......
93	May 8	16	May 8	20 30	....do	....	105,000	70,000	None.	VI 29	......	......	......	......	......	......	......	......
94	May 8	16	May 8	20 30	....do	....	65,000	40,000	None.	VI 27	......	......	......	......	......	......	......	......
95	May 8	15	May 8	20 30	White House	....	92,000	82,000	65,000	VI 23	May 12	1 30	May 15	11	67	63	64	6 20
96	May 8	15	May 8	20 30	....do	....	92,000	65,000	40,000	VI 22	May 12	7 30	May 15	11	67	63	64	6 20
97	May 8	15	May 8	20 30	....do	....	85,000	65,000	40,000	VI 21	May 12	7 30	May 15	11	67	63	64	6 20
98	May 8	16	May 8	20 30	Fort Washington	....	95,000	82,000	75,000	VI 26	May 12	10 30	May 16	10	67	63	64½	7 18
99	May 8	16	May 8	20 30	....do	....	92,000	82,000	45,000	VI 25	May 12	6	May 15	15	67	63	64	6 23
100	May 8	16	May 8	20 30	....do	....	75,000	60,000	35,000	VI 24	May 12	6	May 15	15	67	63	64	6 23
101	May 9	17	May 9	22	....do	....	48,000	40,000	37,000	VI 15	May 12	11	May 16	13	68	64	66	6 20
102a	May 9	17	May 9	22	Moxley's Point	....	30,000	25,000	23,000	VI 14	May 12	11	May 16	13	68	64	66	6 20
102b	May 9	17	May 9	22	Gillers	....	63,600	50,000	45,000	VI 14	May 12	11	May 16	13	68	64	66	6 20
103	May 9	19	May 9	22	Ferry Landing	....	90,000	70,000	None.	VI 19	......	......	......	......	......	......	......	......
104	May 9	19	May 9	22	....do	....	75,000	60,000	None.	VI 18	......	......	......	......	......	......	......	......
105	May 9	17	May 9	22	....do	....	45,000	35,000	None.	......	......	......	......	......	......	......	......	......
106	May 9	17	May 9	22	White House	....	112,000	60,000	50,000	VI 16	May 12	11	May 16	11 30	67	64	66	6 20½
107	May 9	17	May 9	22	....do	....	105,000	90,000	70,000	VI 28	May 12	10 30	May 16	13 30	67	64	66	6 20½
108	May 9	17	May 9	22	....do	....	90,000	75,000	60,000	VI 20	May 12	30	May 16	13 30	67	64	66	6 20½
109	May 10	17	May 10	23	....do	....	105,000	95,000	60,000	VI 27	May 13	17	May 17	11	68	66	66⅓	6 18

110	May 10	17	May 10	23	....do	....	125,000	90,000	60,000	VI	25	May 13	15	May 16	16	68	66	$66\frac{1}{3}$	5	23
111	May 10	17	May 10	23	Ferry Landing	....	85,000	60,000	30,000	VI	31	May 13	17	May 16	11 30	67	66	$66\frac{1}{3}$	5	$18\frac{1}{2}$
112	May 10	17	May 10	23	....do	....	90,000	70,000	45,000	VI	30	May 13	17	May 17	9	68	66	$66\frac{1}{3}$	6	16
113	May 10	17	May 10	23	Gillers	....	75,000	65,000	45,000	VI	29	May 13	17	May 16	13	68	66	$66\frac{1}{3}$	5	20
114	May 10	18	May 10	23	....do	....	70,000	60,000	50,000	VI	17	May 14	6	May 15	10	67	66	$66\frac{1}{2}$	4	16
115a	May 10	20	May 10	23	....do	....	70,000	62,000	62,000	VI	3	May 13	17	May 17	15	68	65	$66\frac{1}{3}$	6	19
115b	May 10	19	May 10	23	Ferry Landing	....	20,000	17,000	10,000	VI	3	May 13	17	May 17	15	68	65	$66\frac{1}{3}$	6	20
116	May 11	......	May 11	22	White House	....	98,000	98,000	90,000	VIII	1	May 15	7	May 19	8	68	65	$66\frac{3}{7}$	......	
117	May 11	......	May 11	22	....do	....	112,000	112,000	100,000	VIII	2	May 15	7	May 19	9	68	65	$66\frac{3}{7}$	......	
118	May 11	......	May 11	22	Lookout gillers	....	120,000	110,000	100,000	IV	28	May 14	16	May 18	8	68	65	$66\frac{1}{3}$	......	
119	May 11	......	May 11	22	Ferry Landing	....	90,000	80,000	75,000	IV	27	May 14	15	May 18	6	68	65	$66\frac{1}{3}$	......	
120	May 11	......	May 11	22	....do	....	112,000	110,000	90,000	IV	4	May 14	16	May 18	7	68	65	$66\frac{1}{3}$	......	
121	May 11	......	May 11	22	....do	....	120,000	105,000	75,000	VI	19	May 14	13	May 18	10	68	65	$66\frac{1}{3}$	......	
122	May 11	......	May 11	22	....do	....	120,000	100,000	80,000	VI	18	May 14	16	May 18	10	68	65	$66\frac{1}{3}$	......	
123	May 11	19	May 11	22	Fort Washington	....	115,000	75,000	60,000	IV	6	May 14	16	May 18	3	68	65	$66\frac{1}{3}$	6	8
124	May 11	19	May 11	22	....do	....	50,000	30,000	25,000	IV	5	May 14	16	May 18	7	68	65	$66\frac{1}{3}$	6	12
125	May 11	18 30	May 11	22	....do	....	112,000	100,000	96,000	IV	29	May 14	16	May 19	3	68	65	$66\frac{3}{4}$	7	$8\frac{1}{2}$
126	May 12	18	May 12	22 50	Ferry Landing	....	112,000	105,000	85,000	IV	30	May 15	15	May 19	16	68	65	$66\frac{1}{3}$	6	22
127	May 12	18	May 12	22 50	....do	....	127,000	120,000	100,000	IV	31	May 15	15	May 19	16	68	65	$66\frac{1}{3}$	6	22
128	May 12	18	May 12	22 50	....do	....	105,000	100,000	75,000	IV	16	May 15	13	May 19	9	68	65	$66\frac{1}{3}$	6	15
129	May 12	18	May 12	22 50	....do	....	127,000	120,000	100,000	IV	17	May 15	13	May 19	9	68	65	$66\frac{1}{3}$	6	15
130	May 12	20	May 12	22 50	Fort Washington	....	105,000	95,000	85,000	IV	1	May 15	12 30	May 19	20	68	65	$66\frac{1}{3}$	7	00
131a	May 12	18	May 12	22 50	....do	....	40,000	35,000	33,000	IV	3	May 15	13	May 20	8	68	65	$66\frac{1}{3}$	7	14
131b	May 12	18	May 12	22 50	White House	....	45,000	40,000	37,000	IV	3	May 15	13	May 20	8	68	65	$66\frac{1}{3}$	7	14
132	May 12	18	May 12	22 50	....do	....	127,000	118,000	97,000	IV	32	May 15	15	May 19	4	68	65	$66\frac{1}{3}$	6	10
133	May 12	18	May 12	22 50	Moxley's Point	....	87,000	87,000	80,000	IV	2	May 15	15	May 20	6	68	65	$66\frac{1}{3}$	7	12
134	May 13	18	May 13	22 15	White House	....	82,000	75,000	65,000	VIII	7	May 16	16	May 21	7	68	65	$66\frac{1}{3}$	7	13
135	May 13	18	May 13	22 15	Moxley's Point	....	112,000	105,000	75,000	VIII	6	May 16	16	May 19	17	68	65	$66\frac{1}{3}$	5	23
136	May 13	18	May 13	22 15	....do	....	105,000	95,000	75,000	VIII	5	May 16	7	May 19	15	68	65	$66\frac{1}{3}$	5	21
137	May 13	18	May 13	22 15	....do	....	75,000	67,000	60,000	VIII	4	May 16	7	May 19	18	68	65	$66\frac{1}{3}$	6	00
138	May 14	18 30	May 14	23 50	....do	....	105,000	97,000	85,000	VIII	13	May 17	14 30	May 21	13	68	65	66	6	$18\frac{1}{2}$
139	May 14	18 30	May 14	23 50	....do	....	75,000	75,000	70,000	VIII	14	May 17	14 30	May 21	14	68	65	66	6	$19\frac{1}{2}$
140	May 14	20	May 14	23 50	Ferry Landing	....	120,000	110,000	50,000	VIII	32	May 18	18	May 20	15	68	65	66	5	19
141	May 14	20	May 14	23 50	....do	....	90,000	88,000	68,000	VIII	15	May 18	6	May 20	9	68	65	66	5	13
142	May 14	20	May 14	23 50	....do	....	67,000	65,000	52,000	VIII	16	May 18	6	May 20	15	68	65	66	5	19
143	May 14	19 50	May 14	23 50	White House	....	105,000	100,000	85,000	VIII	10	May 17	17	May 21	7	68	65	66	6	$11\frac{1}{6}$
144	May 14	19 50	May 14	23 50	....do	....	105,000	85,000	80,000	VIII	11	May 17	17	May 22	9	68	65	66	7	$13\frac{1}{6}$
145	May 14	19 50	May 14	23 50	....do	....	105,000	105,000	98,000	VIII	12	May 17	17	May 21	13	68	65	66	6	$17\frac{1}{6}$
146a	May 14	19 50	May 14	23 50	....do	....	27,000	27,000	17,000	VIII	9	May 17	14	May 21	7	68	65	66	6	$11\frac{1}{6}$
146b	May 14	21	May 14	23 50	Gillers	....	40,000	40,000	28,000	VIII	9	May 17	14	May 21	7	68	65	66	6	10
147	May 15	19 30	May 15	23	Ferry Landing	....	78,000	75,000	65,000	VIII	29	May 19	10	May 21	21	68	65	66	6	$1\frac{1}{2}$
148	May 15	19 30	May 15	23	White House	....	125,000	112,000	82,000	VIII	31	May 19	9	May 22	8	68	65	$66\frac{1}{3}$	6	$12\frac{1}{2}$
149	May 15	19 30	May 15	23	Moxley's Point	....	112,000	97,000	80,000	VIII	30	May 19	9	May 22	2	68	65	$66\frac{1}{3}$	6	$6\frac{1}{2}$
150	May 16	21	May 16	24	Ferry Landing	....	112,000	90,000	70,000	IV	8	May 19	18	May 23	5	68	65	$66\frac{1}{3}$	6	8
151	May 16	18	May 16	24	Gillers	....	52,000	45,000	37,000	IV	7	May 19	18	May 22	15	68	65	$66\frac{1}{3}$	5	21
152	May 16	19	May 16	24	White House	....	135,000	112,000	65,000	IV	9	May 19	18	May 23	1	68	65	$66\frac{1}{3}$	6	6
153	May 16	18 50	May 17	2	Moxley's Point	....	82,000	75,000	50,000	IV	22	May 20	8	May 22	18	68	65	$66\frac{1}{3}$	5	$23\frac{1}{6}$
154	May 16	18 50	May 17	2	..do	....	80,000	75,000	75,000	IV	10	May 19	18	May 22	8	68	65	$66\frac{1}{3}$	5	$13\frac{1}{6}$
155a	May 16	18 50	May 17	2	..do	....	80,000	75,000	55,000	IV	26	May 19	18	May 22	18	68	65	$66\frac{1}{3}$	5	$23\frac{1}{6}$
155b	May 16	......	May 17	2	Gillers	....	25,000	25,000	20,000	IV	26	May 19	18	May 22	18	68	65	$66\frac{1}{3}$	5	$23\frac{1}{6}$
156	May 16	19 50	May 17	2	Fort Washington gillers.	....	90,000	85,000	60,000	IV	24	May 19	18	May 22	15	68	65	$66\frac{1}{3}$	5	$19\frac{1}{6}$

TABLE II.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1883—Continued.

No. of record card.	Eggs taken. Date.	Eggs taken. Hour of day.	Eggs received. Date.	Eggs received. Hour of day.	Whence obtained.	By whom taken.	Total number received.	Number received alive.	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching. Began. Date.	Began. Hour of day.	Ended. Date.	Ended. Hour of day.	Temperature during incubation. Max.	Min.	Av.	Days and hours in incubating. d.	h.
		h. m.		h. m.								h. m.		h. m.				d.	h.
157	May 16	19 50	May 17	2	Fort Washington gillers.	....	82, 000	67, 000	40, 000	IV 23	May 20	8	May 22	8	68	65	66⅓	5	12⅙
158	May 17	21	May 18	1	Moxley's Point ...	....	112, 000	110, 000	80, 000	VI 12	May 21	8	May 23	9	68	65	66½	5	12
159	May 17	21	May 18	1	....do	....	115, 000	105, 000	75, 000	VI 11	May 21	8	May 23	8	68	65	66½	5	11
160	May 17	21	May 18	1	....do	....	112, 000	100, 000	80, 000	VI 10	May 21	8	May 23	8	68	65	66½	5	11
161	May 17	21	May 18	1	....do	....	112, 000	90, 000	75, 000	VI 24	May 21	8	May 23	8	68	65	66½	5	11
162	May 17	21	May 18	1	....do	....	105, 000	90, 000	75, 000	VI 13	May 21	8	May 23	9	68	65	66½	5	12
163	May 17	19	May 18	1	Gillers	....	98, 000	75, 000	60, 000	VI 21	May 21	8	May 24	9	68	64	66	6	14
164	May 17	18	May 18	1	White House	....	65, 000	60, 000	55, 000	VI 22	May 21	8	May 24	9	68	64	66	6	15
165	May 17	18	May 18	1	....do	....	80, 000	72, 000	50, 000	VI 23	May 21	8	May 23	8	68	65	66½	5	14
166	May 17	20 30	May 18	1	Ferry Landing....	....	83, 000	65, 000	None.	VI 20	....	......	....	....	....	....	....	....	....
167	May 18	19 30	May 19	2	Gillers	....	105, 000	95, 000	90, 000	IV 2	May 22	8	May 25	8	68	64	65½	6	13½
168	May 18	21 30	May 19	2	Ferry Landing....	....	60, 000	55, 000	45, 000	IV 1	May 22	8	May 25	8	68	64	65½	6	10½
169	May 18	21 30	May 19	2	White House	....	65, 000	60, 000	50, 000	IV 3	May 22	8	May 25	8	68	64	65½	6	10½
170	May 18	17	May 19	2	....do	....	90, 000	85, 000	85, 000	IV 4	May 22	8	May 25	8	68	64	65½	6	15
171	May 18	21 30	May 19	2	....do	....	112, 000	105, 000	85, 000	IV 32	May 22	8	May 25	9	68	64	65½	6	11½
172	May 18	21 30	May 19	2	Moxley's Point ...	....	95, 000	82, 000	55, 000	IV 5	May 22	8	May 24	10	68	64	65	5	12½
173	May 18	21 30	May 19	2	....do	....	83, 000	75, 000	60, 000	IV 31	May 22	8	May 24	15	68	64	65	5	17½
174	May 18	21 30	May 19	2	....do	....	75, 000	68, 000	52, 000	IV 30	May 22	8	May 24	15	68	64	65	5	17½
175	May 18	21 30	May 19	2	....do	....	80, 000	68, 000	55, 000	IV 29	May 22	8	May 24	15	68	64	65	5	17½
176	May 18	21 30	May 19	2	....do	....	75, 000	65, 000	52, 000	IV 28	May 22	8	May 24	15	68	64	65	5	17½
177	May 19	17	May 20	1 30	White House	....	105, 000	95, 000	70, 000	VI 15	May 22	19	May 26	13	68	64	65½	6	20
178	May 19	17	May 20	1 30	....do	....	105, 000	88, 000	68, 000	VI 14	May 22	19	May 26	13	68	64	65½	6	20
179	May 19	17	May 20	1 30	....do	....	100, 000	90, 000	75, 000	VI 16	May 22	20	May 26	13	68	64	65½	6	20
180	May 19	21	May 20	1 30	Moxley's Point ...	....	112, 000	97, 000	65, 000	VI 17	May 22	20	May 25	9	68	64	65½	5	12
181	May 19	21	May 20	1 30	....do	....	112, 000	95, 000	70, 000	VI 18	May 22	18	May 25	9	68	64	65½	5	12
182	May 19	21	May 20	1 30	....do	....	105, 000	85, 000	68, 000	VI 19	May 22	7	May 25	10	68	64	65½	5	13
183	May 19	21	May 20	1 30	....do	....	120, 000	105, 000	90, 000	VI 20	May 22	19	May 25	10	68	64	65½	5	13
184	May 19	19 30	May 20	1 30	Gillers	....	90, 000	80, 000	60, 000	VIII 16	May 22	19	May 26	13	68	64	65½	6	17½
185	May 19	19 30	May 20	1 30	....do	....	90, 000	85, 000	67, 000	VIII 15	May 22	18	May 25	9	68	64	65½	5	13½
186	May 19	19 30	May 20	1 30	....do	....	85, 000	80, 000	67, 000	VIII 14	May 22	19	May 26	13	68	64	65[illegible]	6	17½
187	May 19	23	May 20	24	Moxley's Point ...	....	95, 000	None.	......	......	....	......	....	....	....	....	....	....	....
188	May 19	23	May 20	24	....do	....	90, 000	None.	......	......	....	......	....	....	....	....	....	....	....
189	May 20	21	May 20	24	....do	....	90, 000	80, 000	45, 000	VI 3	May 23	14	May 26	14	68	64	65⅓	5	17
190	May 20	21	May 20	24	....do	....	80, 000	75, 000	40, 000	VI 4	May 23	14	May 26	21	68	64	65⅓	6	00
191	May 20	21	May 20	24	....do	....	95, 000	85, 000	50, 000	VI 1	May 23	14	May 27	8	68	64	65¼	6	11

192	May 20	21	May 20	24	....do		95,000	90,000	50,000	VI	2	May 23	14	May 26	14	68	64	65½	5	17
193	May 20	19	May 20	24	Gillers		105,000	90,000	55,000	VI	28	May 23	14	May 27	7	68	64	65½	6	12
194	May 20	19	May 20	24	White House		97,000	85,000	75,000	VI	32	May 23	14	May 28	11	68	64	65½	7	16
195	May 20	19	May 20	24	....do		105,000	95,000	80,000	VI	31	May 23	14	May 28	7	68	64	65½	7	12
196	May 20	19	May 22	1 30	Moxley's Point		120,000	None.												
197	May 21	22	May 22	1 30	....do		120,000	105,000	75,000	VIII	4	May 25	8	May 28	7	68	64	65¼	6	9
198	May 21	22	May 22	1 30	....do		105,000	95,000	60,000	VIII	2	May 25	8	May 27	7	67	64	65	6	9
199a	May 21	22	May 22	1 30	....do		30,000	27,000	20,000	VIII	1	May 25	8	May 28	7	68	64	65¼	6	9
199b	May 21	22	May 22	1 30	....do		70,000	63,000	45,000	VIII	1	May 25	8	May 28	7	68	64	65¼	6	9
200	May 21	22	May 22	1 30	....do		100,000	90,000	65,000	VI	27	May 25	8	May 28	8	68	64	65¼	6	10
201	May 20	21	May 22	1 30	White House		37,000	None.												
202	May 21	21	May 22	1 30	....do		85,000	75,000	60,000	VIII	7	May 25	8	May 28	7	68	64	65½	6	10
203	May 21	21	May 22	1 30	... do		75,000	75,000	50,000	VIII	6	May 25	8	May 28	7	68	64	65½	6	10
204	May 21	20 30	May 22	1 30	Gillers		75,000	60,000	60,000	VI	29	May 25	8	May 29	7	68	64	65½	7	10½
205	May 21	20 30	May 22	1 30	....do		75,000	65,000	50,000	VI	30	May 25	8	May 28	7	98	64	65½	6	10½
206	May 21	21 30	May 22	1 30	Lookout gillers		83,000	80,000	60,000	VIII	3	May 25	8	May 28	7	68	64	65½	6	9½
207	May 22	19 30	May 23	1 30	White House		90,000	85,000	55,000	VIII	31	May 26	9	May 29	7	68	64	65½	6	11½
208	May 22	18 30	May 23	1 30	....do		105,000	95,000	65,000	VIII	30	May 26	9	May 29	7	68	64	65½	6	12½
209a	May 22	18 30	May 23	1 30	....do		75,000	70,000	40,000	VIII	29	May 26	9	May 29	7	68	64	65½	6	12½
209b	May 22	18 30	May 23	1 30	....do		30,000	25,000	20,000	VIII	29	May 26	9	May 29	7	68	64	65½	6	12½
210	May 22	18 30	May 23	1 30	....do		112,000	90,000	50,000	VIII	4	May 26	9	May 29	12	68	64	65½	6	17½
211	May 22	23	May 23	1 30	Moxley's Point		120,000	100,000	70,000	VIII	3	May 26	9	May 29	12 15	68	64	65½	6	15¾
212	May 22	23	May 23	1 30	.. do		100,000	100,000	65,000	VIII	2	May 26	9	May 29	11	68	64	65½	6	12
213a	May 22	23	May 23	1 30	....do		40,000	35,000	15,000	VIII	1	May 26	9	May 29	7	68	64	65½	6	8
213b	May 22	23	May 23	1 30	Gillers		80,000	75,000	30,000	VIII	1	May 26	9	May 28	11	68	64	65	6	8
214	May 23	15	May 24	2	White House		105,000	88,000	53,000	IV	12	May 27	8	May 30	11	68	64	66	6	20
215	May 23	15	May 24	2	Moxley's Point		69,000	58,000	40,000	IV	16	May 27	8	May 30	7	68	64	66	6	16
216	May 23	15	May 24	2	....do		120,000	100,000	67,000	IV	13	May 27	8	May 30	11	68	64	66	6	20
217	May 23	15	May 24	2	....do		75,000	70,000	45,000	IV	14	May 27	8	May 30	11	68	64	66	6	20
218	May 23	15	May 24	2	....do		82,000	75,000	60,000	IV	15	May 27	8	May 30	11	68	64	66	6	20
219	May 24	15	May 25	30	Gillers		35,000	30,000	20,000	IV	21	May 28	11 30	May 31	12 30	68	64	66½	6	21½
220	May 25	30	May 25	11 15	Moxley's Point		105,000	97,000	60,000	VIII	16	May 28	11 30	May 31	12 30	68	64	66½	6	12
221	May 25	30	May 25	11 15	... do		85,000	85,000	(*)	IV	19									
222	May 25	30	May 25	11 15	....do		85,000	85,000	(*)	IV	18									
223a	May 25	19 30	May 25	22 30	White House		30,000	30,000	(*)	VI	7									
223b	May 25	18 30	May 25	22 30	Lookout gillers		22,000	20,000	(*)	VI	7									
224	May 25	13	May 25	22 30	Moxley's Point		52,000	50,000	(*)	VI	6									
225	May 26	30	May 26	14	....do		105,000	60,000	58,000	IV	19	May 29	11	June 1	20	69	65	67½	6	19½
226	May 26	20	May 26	23	White House		98,000	98,000	50,000*; 45,000	VIII	29	May 29	9	June 1	20	69	65	67½	6	00
227	May 27	20	May 27	22 30	Gillers		112,000	100,000	90,000	VIII	30	May 30	9	June 3	5	70	66	68	6	9
228	May 27	19	May 27	22 30	... do		83,000	78,000	70,000	VIII	31	May 30	9	June 2	9	69	66	68	5	14
229	May 27	18	May 27	22 30	Ferry Landing		127,000	110,000	50,000*; 55,000	VIII	1	May 30	9	June 2	6	69	66	68	5	12
230	May 27	16	May 27	22 30	Moxley's Point		60,000	55,000	50,000	VIII	2	May 30	9	June 1	17	69	66	67¾	5	1
231	May 27	16	May 27	22 30	... do		75,000	67,000	40,000	VIII	3	May 30	9	June 2	6	69	66	68	5	14
232	May 28	20	May 28	23	Gillers		105,000	97,000	80,000	VI	26	May 31	8	June 3	8	70	66	68⅓	5	12
233	May 28	20	May 28	23	....do		120,000	100,000	30,000*; 50,000	VI	6	May 31	8	June 3	7	70	66	68⅓	5	11
234	May 28	20	May 28	23	....do		110,000	97,000	75,000	VI	7	May 31	8	June 3	7	70	66	68⅓	5	11

* Eggs shipped to Weldon, N. C.

TABLE II.—*Daily register of eggs received and fish hatched at Central Station, U. S. Fish Commission, season of* 1883—Continued.

No. of record card.	Eggs taken. Date.	Eggs taken. Hour of day.	Eggs received. Date.	Eggs received. Hour of day.	Whence obtained.	By whom taken.	Total number received.	Number received alive.	Number of fish produced.	Disposal of eggs while hatching.	Period of hatching. Began. Date.	Period of hatching. Began. Hour of day.	Period of hatching. Ended. Date.	Period of hatching. Ended. Hour of day.	Temperature during incubation. Max.	Temperature during incubation. Min.	Temperature during incubation. Av.	Days and hours in incubating. d.	Days and hours in incubating. h.
		h. m.		h. m.								h. m.		h. m.				d.	h.
235	May 29	21	May 29	22 50	Lookout gillers		105,000	80,000	52,000	VI 1	June 1	7	June 3	23	70	67	69	5	2
236	May 29	21	May 29	22 50	do		68,000	60,000	60,000	VI 2	June 1	7	June 3	23	70	67	69	5	2
237	May 29	20	May 29	22 50	Gillers		105,000	90,000	75,000	VI 3	June 1	7	June 3	23	70	67	69	5	3
238	May 29	20	May 29	22 50	do		105,000	165,000	85,000	VI 32	June 1	7	June 3	23	70	67	69	5	3
239	May 29	20	May 29	22 50	do		120,000	90,000	70,000	VI 31	June 1	7	June 3	23	70	67	69	5	3
240	May 29	20	May 29	22 50	do		105,000	100,000	67,000	VI 30	June 1	7	June 3	23	70	67	69	5	3
241	May 30	21	May 30	23 30	Fort Washington gillers.		105,000	None.											
242	May 30	21	May 30	23 30	Lookout gillers		68,000	75,000	65,000	VI 10	June 2	7	June 4	19	71	68	69½	4	22
243	May 30	21	May 30	23 30	Gillers		112,000	105,000	90,000	VI 23	June 2	7	June 5	19	71	68	69½	5	22
244	May 31	21 30	May 31	23 30	Fort Washington gillers.		52,000	50,000	40,000	VIII 14	June 4	9	June 6	11	72	68	70	5	13½
245	June 1		June 1	23 30	Gillers		100,000	80,000	60,000	VI 11	June 4	12	June 6	15	72	69	70		
246	June 1		June 1	23 30	do		110,000	90,000	80,000	VI 12	June 4	12	June 6	15	72	69	70		
	June 1		June 1	23 30	do		100,000	None.											
247	June 2		June 2	10	do		112,000	95,000	75,000	VI 15	June 4	12	June 6	20	72	69	71		
248	June 2		June 2	10	do		52,000	50,000	30,000	VI 20	June 4	12	June 6	20	72	69	71		
249	June 3		June 3	10	do		110,000	85,000	65,000	VIII 6	June 5	8	June 7	20	73	70	72		
250	June 3		June 3	10	do		95,000	80,000	55,000	VIII 10	June 5	8	June 7	22	73	70	72		
251	June 3		June 3	10	do		90,000	75,000	45,000	VIII 26	June 5	8	June 7	9	73	70	72		
252	June 3		June 3	10	do		90,000	80,000	65,000	VIII 23	June 5	8	June 7	18	73	70	72		
253	June 3		June 3	10	do		90,000	80,000	65,000	VIII 7	June 5	8	June 7	20	74	70	71⅗		
254	June 3		June 3	10	do		90,000	75,000	55,000	VIII 9	June 5	8	June 7	20	74	70	71⅗		
255	June 3		June 3	10	do		90,000	75,000	45,000	VIII 25	June 5	8	June 7	21	74	70	71⅗		
256	June 3	20	June 4	9	do		85,000	50,000	40,000	IV 31	June 6	6	June 8	17	74	70	72	4	21
257	June 3	20	June 4	9	do		82,000	70,000*											
258	June 3	20	June 4	9	do		90,000	53,000	40,000	IV 30	June 6	6	June 8	17	74	70	72	4	21
259	June 4		June 5	9	do		95,000	None.											
260	June 4		June 5	9	do		67,000	None.											
261	June 5		June 6	9 25	do		112,000	None.											
262	June 5		June 6	9 25	do		112,000	None.											
263	June 5		June 6	9 25	do		100,000	None.											
264	June 7	18	June 7	22	Ft. Wash'n seine.		60,000	43,000	40,000	VI 1	June 9	15	June 11	21	76	74	75	4	3
265	June 7	18	June 7	22	do		70,000	62,000	60,000	VI 2	June 9	15	June 11	21	76	74	75	4	3

*Eggs shipped to New York City.

Distribution of shad and herring.

	Shad.	Herring.
Number of shad and herring fry distributed through Central Station	14, 523, 000	6, 850, 000
Furnished by the Battery Station, Susquehanna River	1, 275, 000	....
Furnished by the Fish Hawk, Potomac River	1, 684, 000	6, 850, 000
Furnished by Central Station, Potomac River	11, 564, 000	....
Total	14, 523, 000	6, 850, 000
Number actually planted	12, 408, 000	6, 850, 000

NOTE.—Details of the different shipments will be found in Table III.

TABLE III.—*Shipments of fish and eggs from Central Station, U. S. Fish Commission, during the shad season of* 1883.

Date.		Fish.		Eggs.		Messenger.	Destination.	From what stock.
Day.	Hour.	Variety.	Number.	Variety.	Number.			
1883.								
April 30	4 p. m	Shad	250, 000			Donnelly	Mononky River	Central Station.
May 3	4 p. m	do	175, 000			do	do	Do.
6		do	111, 000			Mace	Little Falls of Potomac River	Do.
11	9 p. m	do	30, 000			Moore, car 1	Cincinnati, Ohio	Fish Hawk.
11	9 p. m	do	198, 000			do	do	Central Station.
11	9 p. m	Herring	4, 300, 000			do	do	Fish Hawk.
14		Shad	410, 000			Mace	Little Falls of Potomac River	Central Station.
15	7.10 a. m	do	300, 000			Quinn	Riverton, Va	Do.
16		do	247, 000			Davenport	Savage, Md	Do.
16	5.20 p. m	do	1, 360, 000			Moore, car 1	Richmond, Va	Do.
16	10.35 p. m	do	277, 000			Quinn	Danville, Va	Do.
18		do	175, 000			Davenport		Fish Hawk.
18	5 p. m	do	175, 000			Stewart	Laurel, Md	Do.
18	5 p. m	Herring	1, 700, 000			do	do	Do.
20	6.20 p. m	Shad	1, 657, 000			Moore, car 1	Illinois and Missouri	Central Station.
20	6.20 p. m	Herring	850, 000			do	do	Fish Hawk.
20	10.35 p. m	Shad	164, 000			Quinn	Chattanooga, Tenn	Do.
20	10.35 p. m	do	86, 000			do	do	Central Station.
22	7.10 a. m	do	250, 000			Davenport	Georgia	Do.
22	10.35 p. m	do	300, 000			Huske	South Carolina	Do.
23	10.35 p. m	do	150, 000			Page	Lynchburg, Va	Fish Hawk.
24	8.40 p. m	do	300, 000			Quinn	Maryland	Do.
25	9.50 p. m	do	550, 000			Moore, car 1	Troy, N. Y	Do.
25	9.50 p. m	do	947, 000			do	do	Central Station.
26	6.30 a. m			Shad	270, 000	Ellis, Charles	Weldon, N. C	Do.
26	10.10 p. m	Shad	329, 000			Quinn	Cumberland, Md	Do.
27	7.10 a. m	do	300, 000			Davenport	Waynesborough, Va	Do.
27	10.10 p. m	do	150, 000			Quinn	Ohio	Fish Hawk.
29	6.30 a. m			Shad	100, 000	Adams Express	Weldon, N. C	Central Station.
29	10.35 p. m	Shad	1, 440, 000			Ellis, car 2	South Carolina and Georgia	Do.
30	6.30 a. m			Shad	30, 000	Adams Express	Weldon, N. C	Do.
31	6.20 p. m	Shad	750, 000			Moore, car 1	Kentucky	Do.
	6.20 p. m	do	725, 000			do	do	Battery Station.
June 3	—a. m	do	200, 000			Quinn	Maryland	Do.
4	10.35 p. m		1, 227, 000			Ellis, car 2	Georgia	Central Station.
5	10.20 p. m			Shad	70, 000	Adams Express	New York City	Do.
8	6.20 p. m	Shad	915, 000			Moore, car 1	Louisiana	Do.
10	—a. m	do	250, 000			Quinn	Colorado	Battery Station.
12	4.20 p. m	do	100, 000			Page	Poughkeepsie, N. Y	Central.
13	12.36 a. m	do	100, 000			do	do	Battery.
	Total	Shad Herring	14, 523, 000 6, 850, 000	Shad	470, 000			

Distribution of carp, &c.—The carp, tench, ides, and goldfish distributed by the U. S. Fish Commission are all bred in the ponds of the Commission, at Washington, Mr. Rudolph Hessel being superintendent of this division of the work of the Commission, the entire product each season being distributed through Central Station. The fish are sent out by car and messenger shipments or by express, as may be most convenient and economical. Mr. J. E. Brown, store-keeper, Central Station, has charge of the details of this branch of the work. The extent of it will be see from the following:

The number of carp applicants supplied was 7,015, scattered through every State and Territory of the United States. The distribution reached 292 congressional districts and 1,308 counties, the average distance of applicants from Washington being 911 miles. The work done was equivalent to sending 7,015 10-pound packages by express an average distance of 911 miles.

PROPAGATION AND DISTRIBUTION OF WHITEFISH.

The following consignments of whitefish eggs were received from the Northville station: December 15, 1883, 1,000,000; December 18, 1883, 1,000,000; total, 2,000,000.

From these were produced 1,600,000 fry, which were distributed as follows:

Date.	Where sent.		Number.
Feb. 22, 1884	To West Virginia Junction, Potomac River (by J. E. Brown)		600,000
Feb. 25, 1884	To Potomac River at Keyser, W. Va		500,000
Mar. 7, 1884	To Potomac River at Little Falls, Maryland		500,000
			1,600,000
	Number of eggs lost during incubation	300,000	
	Number of fish reserved for experiment	100,000	
			400,000
	Total		2,000,000

Hatching began February 11, 1884; ended February 28, 1884.

PROPAGATION AND DISTRIBUTION OF LAKE TROUT.

December 15, 1883, a consignment of 100,000 eggs of the lake or salmon trout were received from the station of the U. S. Fish Commission at Northville, Mich. In reference to these Mr. W. F. Page reports as follows:

	Number.
Died on the way from Northville	1,265
Died up to December 28, 1883, when hatching began	2,478
Died from time hatching began until it ended, March 12, 1884	10,649
Died from time hatching ended until complete absorption of sac, April 8	2,468
Planted in Potomac River at Cumberland, Md	80,000
Reserved for experiment and aquarium exhibits	3,130
	99,990

The planting of both whitefish and the lake trout in the waters of the Potomac is an experiment, the success of which can only be judged by the results. Experience has shown that the lake trout will thrive and grow vigorously when confined in ponds, and it is therefore possible that we may acclimate this species in the waters of the Potomac, as it will probably be temperature-locked, and cannot, therefore, very well stray beyond the limits prescribed for it.

SHAD AND HERRING FISHERIES OF THE POTOMAC.

Accurate daily records of the receipts of shad and herring at the Washington fish-wharves have been kept by Mr. Gwynn Harris, inspector of marine products. The daily receipts given by him fairly indicate the fluctuations in the daily catch, and serve as a measure of the fluctuations in the run of shad and herring in the river. At the close of the fishing season Mr. Harris, by direction of the Commissioner, obtained a summary for the season of the shad and herring of the Potomac reaching the market through Alexandria, Georgetown, and other points not embraced in his Washington returns.

The report made by him will be found summarized in form convenient for reference in Tables IV, V, and VI.

TABLE IV.—*Daily record of the receipts of shad at the Washington fish-wharves for the season of* 1883.

Date.	No. of fish taken.	Date.	No. of fish taken.	Date.	No. of fish taken.	Date.	No. of fish taken.	Date.	No. of fish taken.
Feb. 21..	2	Mar. 21..	9	Apr. 11 ...	6,017	May 2 ...	5,489	May 23...	1,137
Feb. 24..	1	Mar. 22..	361	Apr. 12 ...	7,951	May 3 ...	4,564	May 24...	1,844
Feb. 27..	1	Mar. 23..	187	Apr. 13 ...	8,338	May 4 ...	4,873	May 25...	1,117
Mar. 3..	11	Mar. 24..	54	Apr. 14 ...	9,206	May 5 ...	4,789	May 26...	1,485
Mar. 5..	17	Mar. 26..	263	Apr. 16 ...	7,097	May 7 ...	4,784	May 28...	2,278
Mar. 6..	22	Mar. 27..	616	Apr. 17 ...	15,865	May 8 ...	3,288	May 29...	438
Mar. 7..	4	Mar. 28..	681	Apr. 18 ...	6,814	May 9 ...	3,866	May 30...	696
Mar. 8..	2	Mar. 29..	3,259	Apr. 19 ...	9,443	May 10 ...	3,222	June 1...	449
Mar. 9..	24	Mar. 30..	3,220	Apr. 20 ...	10,346	May 11 ...	2,845	June 2...	326
Mar. 10..	7	Mar. 31..	1,609	Apr. 21 ...	5,087	May 12 ...	3,532	June 4...	296
Mar. 12..	56	Apr. 2..	1,261	Apr. 23 ...	11,112	May 14 ...	3,678	June 5...	388
Mar. 13..	7	Apr. 3..	1,037	Apr. 24 ...	6,592	May 15 ...	2,530	June 6...	284
Mar. 14..	95	Apr. 4..	2,490	Apr. 25 ...	6,086	May 16 ...	2,772	June 7...	340
Mar. 15..	106	Apr. 5..	2,472	Apr. 26 ...	6,784	May 17 ...	1,649	June 8...	297
Mar. 16..	151	Apr. 6..	2,974	Apr. 27 ...	6,673	May 18 ...	1,804	June 9...	80
Mar. 17..	11	Apr. 7..	6,156	Apr. 28 ...	6,040	May 19 ...	1,585		
Mar. 19..	174	Apr. 9..	5,036	Apr. 30 ...	5,602	May 21 ...	2,809		257,687
Mar. 20..	309	Apr. 10..	11,362	May 1 ...	7,784	May 22 ...	1,269		

TABLE V.—*Daily record of the receipts of herring at the Washington fish wharves for the season of* 1883.

Date.	No. of fish taken.	Date.	No. of fish taken.	Date.	No. of fish taken.	Date.	No. of fish taken.	Date.	No. of fish taken.
Feb. 19..	20	Mar. 19..	2,915	Apr. 10 ...	81,791	May 2 ...	164,541	May 24...	21,352
Feb. 21..	90	Mar. 20..	4,499	Apr. 11 ...	47,339	May 3 ...	122,511	May 25...	7,463
Feb. 24..	196	Mar. 21..	290	Apr. 12 ...	60,386	May 4 ...	142,374	May 26...	11,602
Feb. 26..	115	Mar. 22..	2,483	Apr. 13 ...	106,843	May 5 ...	162,837	May 28...	19,063
Feb. 27..	465	Mar. 23..	490	Apr. 14 ...	120,713	May 7 ...	234,248	May 29...	9,847
Feb. 28..	39	Mar. 24..	464	Apr. 16 ...	139,914	May 8 ...	68,718	May 31...	10,440
Mar. 3..	780	Mar. 26..	3,720	Apr. 17 ...	112,057	May 9 ...	85,478	June 1...	3,687
Mar. 5..	530	Mar. 27..	5,698	Apr. 18 ...	120,027	May 10 ...	134,737	June 2...	1,362
Mar. 6..	560	Mar. 28..	3,154	Apr. 19 ...	143,174	May 11 ...	121,877	June 4...	604
Mar. 7..	290	Mar. 29..	10,549	Apr. 20 ...	219,298	May 12 ...	84,925	June 5...	1,892
Mar. 8..	210	Mar. 30..	8,869	Apr. 21 ...	121,858	May 14 ...	102,423	June 6..	406
Mar. 9..	224	Mar. 31..	13,424	Apr. 23 ...	267,968	May 15 ...	92,291	June 7...	640
Mar. 10..	280	Apr. 2..	9,091	Apr. 24 ...	194,169	May 16 ...	57,867	June 8.	440
Mar. 12..	661	Apr. 3	10,730	Apr. 25 ...	120,159	May 17 ...	63,627	June 9...	900
Mar. 13..	523	Apr. 4	13,950	Apr. 26 ...	102,567	May 18 ...	72,381		
Mar. 14..	1,095	Apr. 5..	33,584	Apr. 27 ...	128,192	May 19 ...	62,870		4,914,261
Mar. 15..	2,105	Apr. 6..	33,801	Apr. 28 ...	171,213	May 21 ...	98,667		
Mar. 16..	1,783	Apr. 7..	66,331	Apr. 30 ...	183,415	May 22 ...	29,089		
Mar. 17..	420	Apr. 9..	60,554	May 1 ...	228,618	May 23 ...	17,419		

TABLE VI.—*Statistical summary of the shad and herring fisheries of the Potomac River for the season of* 1883.

	Shad.	Herring.
Landed at Washington	257,687	4,914,261
Landed at Alexandria, Va	81,429	2,331,000
Landed at Georgetown	2,200	360,000
Shipped from Glymont, Md	14,250	....
Shipped from Piney Point, Md	....	78,000
Shipped from Kinsale, Va	4,100	24,000
Shipped from Cone River	3,450	32,000
Sold on the different shores	16,700	1,250,000
Total	379,816	8,989,261

It will be seen from this summary that the herring product is about the same as that for 1882; probably a little in excess of that year. The shad figures indicate a decrease of 70,000 as compared with last year.

SHIPMENT OF SHAD EGGS BY EXPRESS.

The possibility of shipping shad eggs collected from the fishing shores to Central Station at Washington by what is known as the "dry method" was experimentally demonstrated in the latter part of the season of 1881. This method was generally adopted for the season of 1882, and has been continued with the best results during the season of 1883.

The transportation of eggs from the fishing shores to Washington being by boat, and in charge of a messenger, the eggs were in great measure guarded from rough handling or jarring during transportation, but the satisfactory results obtained in our work on the Potomac gave no positive assurance that we could adopt the same methods with like satisfaction in making shipments of shad eggs by express.

A method by which we could satisfactorily transfer shad eggs from the collecting stations to points in the vicinity of the waters to be stocked, and where they could be hatched successfully, promised results of such importance to fish-culture that Mr. S. G. Worth, the active and progressive superintendent of fisheries for North Carolina, made arrangements early in the season of 1883 to forward the eggs intended for stocking the Neuse River from Avoca, his collecting station on the Albemarle Sound, to Raleigh, N. C., by ordinary express shipment.

To guard against rapid fluctuations of temperature, which is always disastrous, and at the same time to retard development during transportation. the eggs were placed on wire-bottom frames, covered with cotton cloth. A stack of twelve or fifteen of these were strapped together, placed in a packing box, and surrounded on all sides with a layer about 6 inches thick of chopped hay and pounded ice.

The cases thus prepared were forwarded by steamer to Franklin, Va., and thence by rail to Raleigh, N. C. Arriving at this point, the eggs were transferred to hatching jars, and the young fry obtained were planted in the Neuse River, in the vicinity of Raleigh. These experiments were fairly successful. They indicated that when the conditions of successful transportation were established by experience, the method would prove an important adjunct to fish-cultural work by greatly cheapening the cost of production and distribution.

To enable Mr. Worth to continue his experiments, I was instructed by the Commissioner to forward to him, at the rock-fish hatching station at Weldon, N. C., several lots of eggs by messenger and by express. The details of these experimental shipments, which were made under the immediate personal supervision of Mr. Page, superintendent of propagation, Central Station, were reported as follows:

"The first shipment consisted in part of lot 221, 85,000, and lot 222, 85,000. They were taken at Moxley's Point at 12.30 a. m. May 25, and transported to Central Station on dry trays, reaching there at 11.15 a. m. on the 25th. They were then put into McDonald jars and kept there until 2.30 p. m. on the 25th, when they were repacked on dry trays. They remained crated until 6.30 a. m. on the 26th, receiving frequent sprinkling with water. Also shipped in same lot 223*a*, 30,000, from White House, taken at 7.30 p. m., 25th; lot 223*b*, 20,000, from the gillers, taken at 6.30 p. m., 25th; and lot 224, 50,000, from Moxley's Point, taken at 1 p. m., 25th. These last three lots, making 100,000, reached Central Station at 10.30 p. m., 25th; and were immediately placed in McDonald jars. They were repacked at 6 a. m. on the 26th. The entire shipment, 270,000, was sent by rail, in charge of Mr. Charles Ellis, to Mr. S. G. Worth, superintendent of North Carolina Fish Commission, at Weldon, N. C.

"The second shipment consisted of part of lot 226, of 50,000, from White House, taken at 8 p. m., May 26; reached Central Station 11 p. m., May 26; placed in McDonald jar till 4 a. m. on the 29th, and then

taken out and repacked. The remainder of this was a part of lot 229, of 50,000, from Ferry Landing, taken at 6 p. m., 27th; reached Central Station at 10.30 p. m., May 27; was put in jars, and remained there till 5 a. m., 26th; then repacked for shipment. These two lots were put on our trays and crated in the manner usually employed in the Potomac River work; but in addition were packed in large outer case, with 6 inches of ice and hay (three-fourths bulk of hay, one-fourth bulk ice) on all sides. These were shipped on 6.30 a. m. train, by Adams Express Company, to Mr. S. G. Worth, superintendent of North Carolina Fish Commission, Weldon, N. C. The remainder of lot 226 began to hatch at 9 a. m., 30th, and finished at 8 p. m., June 1. The remainder of lot 229 began to hatch at 9 a. m., 30th, and finished 6 a. m., June 2.

"The third shipment consisted of part of lot 233, of 30,000, from the gillers, taken at 8 p. m. on the 28th of May; reached Central Station at 11 p. m., 28th; were immediately placed in jar, and remained there till 5 a. m., 30th; then taken out for shipment and packed as in the second shipment, except that flannel bottom trays were substituted for our wire-bottom cotton-covered trays. This lot also was shipped by Adams Express Company to Mr. Worth, at Weldon, N. C. The remainder of this lot began to hatch at 8 a. m. of the 31st, and finished at 7 a. m. of June 3."

In the first experiment, in which no provision was made to control fluctuations of temperature, the eggs proved almost a total loss. The second and third lots reached Weldon in good condition, and were hatched with less than 5 per cent of loss.

The results of these experiments were detailed by Mr. S. G. Worth, superintendent of fisheries for North Carolina, as follows:

"Of the three lots sent from Washington to the Weldon station on May 26, 29, and 30, the first lot of 270,000 suffered a loss of 95 per cent, due, I suppose, to the fact that segmentation had not taken place; that the melting ice was immediately on the top of the trays; and that uniform temperature was not maintained on the way, there being no surrounding cushion of moss or other non-conductor, and, further, that there was no elastic cushion between them and the vibrating floor of the car.

"The second lot of 100,000, part forty-six hours and the rest sixty hours old on arrival, suffered a loss in transit of only 3 per cent, and hatched without further appreciable loss.

"The third lot, containing 30,000 eggs, forty-four hours old on arrival, suffered a loss of 4 per cent on the way, and produced excellent results in hatching."

The season having closed at Weldon, a fourth experiment was made and reported as follows:

"Lot 257, of 70,000, from the gillers, near Fort Washington, taken 8 p. m., June 3, reached Central Station 9 a. m., June 4; were put into jar, and remained till 6 p. m., June 5; were then repacked, as in No. 2 ship-

ment, and forwarded on the 10.20 p. m. train, by Adams Express Company, to M. McDonald, care Eugene Blackford, Fulton Market, New York City. Corresponding lots remaining at the hatchery began to hatch at 6 a. m. on June 6 and finished at 5 p. m. of June 8th."

These eggs reached me in as good condition apparently as when they left Washington; were transferred to McDonald jars, and were exhibited in process of hatching before a meeting of the American Fish-cultural Association, then in session at New York.

These eggs when shipped were forty-six hours from impregnation, and the outline of the fish had begun to show plainly. It is at this stage that the eggs seem to bear transportation best. The egg seems to be peculiarly sensitive to injury at that period of rest which immediately succeeds the granulation of the embryonic disk. Handling them at this stage is almost certain to prove fatal.

It will require further experiments in the direction above indicated before we attempt a radical departure from the methods now in use; but we may expect in the near future to send eggs instead of young fish to localities remote from our collecting stations, and as a package containing 100,000 eggs may be sent at about the same cost as a can containing 20,000 fry, the expense of distribution will thus be greatly diminished.

FLUCTUATIONS OF WATER TEMPERATURE IN THE CHESAPEAKE REGION.

The diagram showing fluctuations of water temperature in the Chesapeake region furnishes very interesting and suggestive data for discussion. By reference to it it will be seen that, during the winter months, the water temperatures on the ocean plateau, outside of the capes, is higher than that of Chesapeake Bay or of the Potomac River. The latter part of February, or early in March, the temperature of the bay waters rises above that of the ocean waters outside. Coincident with this, the shad make their appearance in the Chesapeake and are taken in the pounds which are set in salt water along the shores of the bay. About the 1st of April the temperature of the water in the Potomac River rises above the temperature of the water in the bay. Coincident with this is the beginning of the shad season in the river (see tables of Gwynn Harris). The lesson taught by the diagram is that shad do not enter our rivers to spawn until the temperature of the river waters is higher than that of the salt water from which they come. The observations of 1882–'83 but repeat those of 1880–'81–'82, and confirm the conclusion already arrived at and published. Should the waters of either the Potomac or the Susquehanna continue during the season at a lower temperature than those of the bay, we would have no run either of shad or glut herring during the season.

PLATE I.

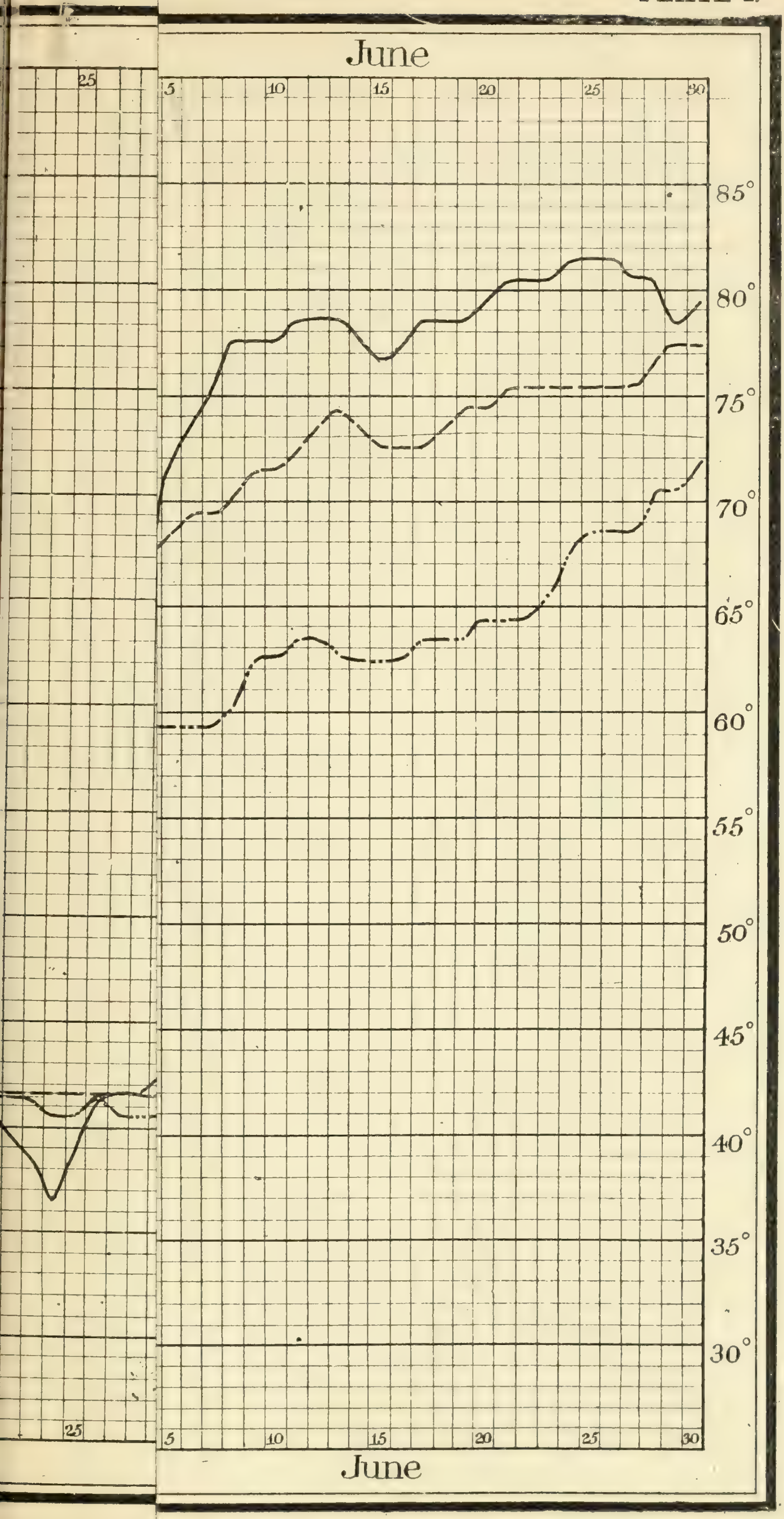

June
25
5
10
15
20
25
30
85°
80°
75°
70°
65°
60°
55°
50°
45°
40°
35°
30°
25
5
10
15
20
25
30
June


DIAGRAM SHOWING THE
FLUCTUATIONS OF WATER TEMPERATURE
IN THE
CHESAPEAKE BAY AND POTOMAC RIVER
FROM JULY 1ST 1882 TO JUNE 30TH 1883.
Constructed from Observations made at
Winter Quarter Shoals Va. Wolf Trap Bar Va. and
at Washington D.C.
August
September
October
November
December
January
February
March
April
May

XXIX.—REPORT OF SHAD OPERATIONS CONDUCTED AT FORT WASHINGTON, MARYLAND, IN THE SPRING OF 1883.

By Lieut. William C. Babcock, U. S. N.

I have the honor to make the following report of operations conducted at Fort Washington, Md., under the direction of the Commissioner, in the collection of shad eggs on the Potomac River during the spring of 1883:

The honorable Secretary of War having, at the request of the U. S. Commission of Fish and Fisheries, granted to it permission to occupy the buildings belonging to the United States at Fort Washington, Md., it was deemed best to establish there a station for the collection of fish eggs on the upper Potomac as far down as Chapman's Point, Md.

The method heretofore followed had been to quarter the spawn-takers on the fishing-shores, a steamer making daily visits to each to collect the eggs that had been procured. There were many objections to this, on account of expense, lack of system in collection, and bad feeling among the fishermen. Therefore, a station was established having Fort Washington, Md., as headquarters, with a force of nine men: 4 first-class spawn-takers, 3 second-class spawn-takers, 1 apprentice spawn-taker, and 1 cook; to which was afterwards added a steam-launch, with a crew of 2 men. Two tents, 7 bateaux, a large number of pans, crates, buckets, &c., completed the outfit. The men were comfortably quartered in barracks near the fort, and transported daily by the steam-launch to the several fishing-shores, returning to the fort with the eggs collected.

I found a decided prejudice existing among the fishermen because the elements had not been favorable last year. As it could not be attributed to anything else, in their minds, the fishermen seemed to have selected the Commission to bear all the blame, and therefore demanded exorbitant prices for the right of collecting fish eggs on their shores, saying the injury to the fish was great and the amount of damage could not be estimated. In one instance the owner of a fishing-shore declined to sell any fish to the employés of the United States Fish Commission for the full market-price at his shore. Matters were finally arranged in a satisfactory manner, and, as everything has been done to aid and conciliate the fishermen, even they in time must be convinced that the efforts of the Commission are intended for their benefit. Such antag-

onism, however, should lead the Commission to establish its own stations for seine-hauling and collecting fish eggs in certain places known to be well adapted to that purpose, thereby placing itself above any local prejudice.

There exists at Fort Washington, Md., a well-known fishing-shore, extending northeast from the light-house, between it and Swan Creek. The Commission intended to fish this shore with its own seine, in order to test its capabilities for a permanent station, but a man named L. G. Harron, having produced a permit from the commandant of the arsenal stating that he was fully prepared and had spent a great deal of money on his outfit, was granted permission to fish the shore, on the conditions of supplying fish for the employés of the Commission, agreeing to fish his seine until the 10th of June, unless it was mutually deemed a failure. The limits of the station were the Upper Potomac River as far as Chapman's Point, Maryland, afterwards reduced to and including White House, Va. Above Fort Washington there are no seines and consequently few gill-nets, although numerous pound-nets exist in the Georgetown channel near the Long Bridge.

At Fort Washington the channel of the river narrows to about a quarter of a mile, with a steep bluff on the Maryland side, the water suddenly deepening to 70 feet; from this point the river widens into a large, shallow bay extending to White House, Va., miles in length, and from 1 to 2 miles in breadth. Here are situated the fishing-shores of Mockley's and Bryan's Points, Terry Landing, and White House, besides numerous pound and gill nets. This bay has long been known as the favorite resort of spawning fish, which seem to run on the flats near Piscataway Creek seeking a place to spawn. It is here that most of the shad eggs on the Potomac are taken; in good seasons the yield should be from 30,000,000 to 50,000,000 of shad eggs; under most unfavorable conditions this year, it was nearly 22,000,000.

The general condition of the Potomac River, in regard to fisheries this season, has been bad—rains, sudden and frequent changes of temperature, and very muddy water. On the 14th of April the temperature of the river was unusually high, at 58° F., falling gradually on the 26th until it reached 51° F., the weather during the latter part of April being cold and rainy. During the month of May the temperature gradually increased from 53° F. to 68° F., and on June 20 it had reached 81° F.; the shad taken at this time were blighted or had already spawned.

The first shad eggs, 64,000 in number, were taken on April 14, five days earlier than the previous year; the greatest number of eggs, 1,140,000, were taken on May 19, and delivered in Washington in fine condition. During the first part of the season the condition of the eggs was not good; sometimes they were kept nearly twenty-four hours awaiting transportation to the hatching station at the Armory Build-

ing, Washington, D. C. The bad condition of the eggs, in my opinion, was due also to the use of pans with strainer bottoms, many of the eggs being thus broken; as soon as this was discovered the use of these pans was discontinued.

On May 8 the steamer Lookout reported for service, and thereafter made daily trips from Washington to the fishing grounds, returning with the eggs collected. Most of the eggs were taken between the hours of 4 and 11 p. m., and when transported to the hatchery as soon as possible, they were invariably found to be in good condition.

During the month of April the temperature at night was frequently as low as 49° F., which destroyed the eggs if they were kept overnight; during the month of June great heat caused the same effect. The temperature of 60° to 65° F. is the most favorable for the preservation of shad eggs; above or below that the loss increases rapidly for comparatively small changes of temperature. The eggs were invariably transported on the trays, both for convenience and safety, as they had to be carried in a wagon from the steamer to the hatchery one-half a mile over a roughly paved street; the greatest care was taken at all times to protect them from exposure.

Written instructions were furnished the spawn-takers and the utmost care taken in the manipulation of the eggs, uniformity being insured by a daily report from the hatchery as to the condition of the eggs taken on the day previous; this was furnished to the spawn-taker who could then tell in what condition his eggs were received.

All the haul-seines had been removed by May 28, leaving the gill-nets as the only means of supply. Very few male shad were taken in gill-nets, but numerous females; there being no milt it was impossible to impregnate the eggs; for this reason the losses which occur every year at the best spawning time of the fish are very great and finally cause an end to spawn-taking.

On the 21st of May, without any consultation, Mr. Harron removed his seine, thus violating the contract with the Commission. His seine was 110 fathoms in length and 24 feet deep; it worked well enough but yielded poor results, only 752 shad and 24,226 herring having been taken between April 14 and May 21. It was a good thing that he left, for directions were then issued to prepare a seine to be worked by employés of the Commission. The seine berth was sounded out and found to have a depth varying from 10 to 71 feet, thus showing that the lead line of Harron's seine hardly ever touched bottom. We had previously discovered that most of the fish taken in gill-nets were found at the bottom of the net; consequently we made preparations to fish the berth so as to reach the bottom.

A seine was rigged 115 fathoms in length and 40 feet deep, having for a lead line 3-inch bolt-rope, this heavy lead line sinking it to the bottom. It was ready on June 5 and worked admirably, there being but one ob-

struction in the berth. The shad taken were placed in large live-boxes. The females invariably died a few hours afterwards; the male shad were kept for a week in fine condition, an accident to the live-boxes causing their escape. Compared with Harron's seine, the new seine was a great success; it caught 231 shad in eight days at the end of the season; his caught only 752 in forty-one days at the best time of the year. We were too late, however, to realize any great results, for most of the female shad taken were blighted or had already spawned; had we been ready a week sooner we could have saved from 2,000,000 to 3,000,000 of shad eggs by keeping the male shad alive in the boxes. A few herring, small rock, mullets, and catfish were the only other fish taken in the seine.

The seine is now complete and on hand; it can be put into the water in a few days if necessary; to work it will cost the Commission about $11 per day; if it is hauled from May 1 to June 10 it ought to yield very good results, especially when the other seines are removed. A seine-boat will be required, costing about $250, and two capstans at $8 each; these articles, with the material on hand, will complete the outfit.

About 300 yards to the northward and eastward of the light-house there is a bank of iron ore projecting out on the east side of the channel at the depth of 54 feet; soundings right off the bank show 72 feet; if two iron bells (mushroom anchors) are placed upon it they will keep the seine from fouling. The seine can be hauled well only at dead high water or on the ebb tide; when the ebb tides are early the hauls are not favorable for spawning fish. The range of the seines near Fort Washington is such that there is almost a regular succession of hauls during the entire day.

In view of the comparatively small expense and the advantages offered by the Fort Washington seine, especially as to the capture of male shad at a time of the year—*i. e.*, at the end of the fishing season—when it is well-nigh impossible to obtain them, I think it would be well for the Commission to maintain a seine from May 1 to the end of the season. If it is desired to continue the experiment in regard to penning shad, it might be well to haul the seine as soon as the season opens.

In this report allusion has been made to the collection of shad eggs only, as they could be procured in large numbers. Attempts were made at the end of the shad season to obtain eggs of the sturgeon and other fishes, but they were unsuccessful, as none of those taken were found to be in spawning condition. On the 9th of June we stopped seining, and on the 20th, the fishing season being entirely ended, the station was closed and the outfit returned to Washington.

In conclusion, I wish to speak most favorably of the merits of Mr. James Carswell, who had immediate charge of the spawn-taking force. His ability and energy in the position he occupied were such that I would especially recommend him to your consideration.

Mr. John Luckett was in charge of the haul-seine and gill-nets. Having had many years' experience on the Potomac River, his services and information were most valuable. The abilities and conduct of the other employés at the station were such that I would unhesitatingly recommend them for future employment.

Messrs. C. W. Mitchell, of Chapman's Point, Maryland, and Wm. E. Stuart, of White House, Va., owners of those shores, have been of great service and assistance to the employés of the Commission. Being men of education and intelligence, they have aided us on all occasions.

Accompanying this report will be found a daily meteorological record; also a record of the spawn-taking operations conducted this season on the Potomac River.

Record of meteorological observations made at Fort Washington, Maryland, on the Potomac River, from April 14 to June 20, 1883, by James Carswell.

Date.		Temperature of—						Depth of water at station.	Wind.				Condition of—		
Day of week.	Day of month.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.		Direction.	Intensity.	Direction.	Intensity.	Sky.	Sky.	Water.
		°	°	°	°	°	°	Feet.							
Saturday	Apr. 14	59	60	58	56	60	58	40	S.	Mild	SE.	Mild	Clear	Clear	Muddy
Sunday	Apr. 15	60	59	58	61	60	59	40	S.	Heavy	S.	do	do	do	do
Monday*	Apr. 16	50	56	56	49	54	54	40	NE.	do	N.	Moderate	Cloudy	Cloudy	do
Tuesday	Apr. 17	58	58	57	59	58	57	40	NW.	do	W.	do	do	Clear	do
Wednesday	Apr. 18	64	60	58	60	60	59	40	S.	do	SE.	do	Clear	do	do
Thursday †	Apr. 19	61	60	59	60	60	59	40	S.	do	SE.	Heavy	Cloudy	Cloudy	do
Friday	Apr. 20	56	58	57	56	54	52	40	W.	Light	NW.	do	do	do	do
Saturday †	Apr. 21	57	59	58	56	59	58	40	SE.	do	SE.	do	Clear	do	do
Sunday †	Apr. 22	54	57	56	52	56	55	40	NE.	Moderate	NE.	do	Cloudy	do	do
Monday †	Apr. 23	54	56	55	46	56	55	40	NE.	Heavy	NE.	do	do	do	do
Tuesday †	Apr. 24	41	53	54	50	52	54	40	SW.	Light	NW.	do	do	do	do
Wednesday	Apr. 25	39	49	50	45	52	52	40	NW.	do	NW.	do	do	do	do
Thursday	Apr. 26	49	50	51	48	50	51	40	N.	do	SE.	Moderate	do	do	do
Friday	Apr. 27	56	50	51	58	53	54	40	SE.	do	SE.	do	Clear	Clear	do
Saturday †	Apr. 28	58	52	53	58	52	53	40	SE.	do	N.	do	Cloudy	Cloudy	do
Sunday †	Apr. 29	54	50	51	50	50	51	40	SW.	Heavy	N.	do	do	do	do
Monday	Apr. 30	46	50	51	49	50	51	40	SE.	Moderate	NE.	do	Clear	do	do
Tuesday	May 1	49	53	53	54	54	54	40	SW.	Light	NE.	Light	do	do	do
Wednesday	May 2	55	54	53	56	57	56	40	NE.	do	SE.	do	do	Clear	do
Thursday	May 3	60	57	56	65	59	59	40	NE.	do	NE.	do	do	do	do
Friday	May 4	69	62	60	68	63	62	40	S.	do	SE.	do	do	do	Clearing
Saturday †	May 5	59	60	61	65	61	60	40	E.	do	NE.	do	Cloudy	Cloudy	do
Sunday	May 6	64	61	62	66	61	62	40	SE.	do	NE.	do	do	do	do
Monday	May 7	66	62	63	68	64	63	40	S.	do	E.	do	Clear	do	do
Tuesday	May 8	68	64	63	70	65	65	40	S.	do	SE.	do	do	do	do
Wednesday	May 9	68	66	65	68	67	68	40	SE.	do	SE.	do	do	Clear	do
Thursday	May 10	66	68	68	70	69	68	40	SE.	do	S.	do	do	do	do
Friday †	May 11	70	69	68	68	67	68	40	SE.	do	E.	do	Cloudy	do	do
Saturday	May 12	63	65	66	69	68	68	40	NE.	do	SE.	do	Clear	do	do
Sunday	May 13	65	68	68	65	68	68	40	N.	do	NE.	do	do	Cloudy	do
Monday †	May 14	65	68	68	65	68	68	40	NE.	do	NE.	do	Cloudy	do	do
Tuesday	May 15	67	65	66	64	63	64	40	E.	Heavy	NE.	Heavy	do	do	do
Wednesday	May 16	64	60	60	64	60	60	40	N.	do	NE.	do	Clear	Clear	do
Thursday	May 17	65	60	61	68	60	60	40	N.	Light	NE.	Light	do	do	do
Friday	May 18	68	66	64	69	67	66	40	SE.	do	E.	do	do	do	Clear
Saturday	May 19	67	67	66	69	67	66	40	SE.	do	SW.	do	do	do	do

Sunday	May 20	69	67	66	70	68	68	40	NE.	do	E.	do	do	do	do
Monday	May 21	66	68	67	67	67	67	40	NE.	do	N.	Heavy	do	Cloudy	do
Tuesday	May 22	65	66	65	65	66	65	40	NE.	do	N.	do	Cloudy	do	do
Wednesday	May 23	65	64	64	58	62	63	40	NE.	Heavy	NW.	do	do	do	Muddy
Thursday	May 24	64	60	60	68	61	62	40	NW.	Light	E.	Light	Clear	Clear	do
Friday	May 25	65	62	62	67	64	63	40	W.	do	SE.	do	do	do	do
Saturday	May 26	65	66	67	70	68	68	40	SW.	do	S.	do	do	do	do
Sunday	May 27	68	68	67	75	69	68	40	SW.	do	SE	do	do	do	do
Monday	May 28	70	66*	64	75	66	66	40	S.	do	NW.	do	do	do	Clearing
Tuesday	May 29	68	67	67	75	69	68	40	SE.	do	S.	do	do	do	do
Wednesday	May 30	68	67	67	76	68	67	40	SE.	do	SW.	do	do	do	do
Thursday	May 31	67	68	67	76	69	68	40	W.	do	SW.	do	do	do	do
Friday	June 1	68	68	68	78	69	69	40	NW.	do	W.	do	do	do	do
Saturday	June 2	70	68	68	76	68	68	40	E.	do	NE.	do	do	do	do
Sunday	June 3	72	70	70	76	71	70	40	SE.	do	S.	do	do	do	do
Monday	June 4	72	73	73	76	74	74	40	S.	do	SW.	do	do	do	Clear
Tuesday	June 5	71	73	74	75	78	76	40	E.	do	SE.	do	do	do	do
Wednesday	June 6	76	77	76	79	78	76	40	SW.	do	SW.	do	do	do	do
Thursday	June 7	78	75	75	80	79	78	40	SE.	do	S.	do	do	do	do
Friday	June 8	75	77	77	81	78	78	40	S.	do	SW.	do	do	do	do
Saturday	June 9	70	78	78	79	79	79	40	W.	do	SE.	do	Cloudy	do	do
Sunday	June 10	76	78	77	84	.9	79	40	SW.	do	E.	do	Clear	Cloudy	do
Monday	June 11	70	76	76	82	78	77	40	SE.	Heavy	SE.	Heavy	Cloudy	do	Roily
Tuesday	June 12	75	77	77	84	79	79	40	S.	Light	SW.	Light	Clear	Clear	do
Wednesday	June 13	80	79	79	86	80	80	40	SE.	do	SW.	do	do	do	do
Thursday	June 14	78	78	77	82	79	79	40	SE.	do	S.	do	do	do	do
Friday	June 15	72	76	77	73	77	77	40	S.	do	SW.	do	do	do	do
Saturday	June 16	75	76	76	76	76	76	40	SE.	do	SE.	do	do	do	Clear
Sunday	June 17	80	79	79	86	81	81	40	S.	do	SW.	do	do	do	do
Monday	June 18	80	79	79	86	80	80	40	SE.	do	S.	do	do	do	do
Tuesday	June 19	83	81	81	85	81	81	40	E.	do	E.	do	do	do	do
Wednesday	June 20	80	80	80	86	82	81	40	SE.	do	SE.	do	do	do	do

* Rain all day † Rain.

Record of spawn-taking operations conducted at Fort Washington, Maryland, on the Potomac River, from April 14 to June 13, 1883, by James Carswell.

Date.		Total length of haul-seines visited.	Fish taken by—			Ripe fish.		Eggs obtained.
			Haul-seines.		Gill-nets.			
Day of week.	Day of month.		No. shad.	No. herring.	No. shad.	Males.	Females.	
		Fathoms.						
Saturday	Apr. 14	450	450	200		7	4	65,000
Sunday	Apr. 15	450	240	100		15	8	300,000
Monday	Apr. 16	450	450	450	50	10	5	140,000
Tuesday	Apr. 17	450	187	150	60	25	18	460,000
Wednesday	Apr. 18	450	125	175	25	7	5	85,000
Thursday	Apr. 19	1,450	250	700	40	20	13	410,000
Friday	Apr. 20	450	200	100	55	9	5	210,000
Saturday	Apr. 21	1,750	150	400	36	17	11	465,000
Sunday	Apr. 22							
Monday	Apr. 23	1,250	95		15	8	3	
Tuesday	Apr. 24	500	50		20			
Wednesday	Apr. 25	1,750	75		25			
Thursday	Apr. 26	1,750	125		55	2	1	48,000
Friday	Apr. 27	1,750	150		60			
Saturday	Apr. 28	1,750	133					32,000
Sunday	Apr. 29	1,750	50					74,000
Monday	Apr. 30	1,750	450			1	1	32,000
Total								2,321,000
Tuesday	May 1	1,750	350			10	8	235,000
Wednesday	May 2	1,750	425			15	15	717,000
Thursday	May 3	1,750	415			17	15	724,000
Friday	May 4	1,750	475			16	14	768,000
Saturday	May 5	1,750	500			9	10	450,000
Sunday	May 6	1,500	313			18	16	956,000
Monday	May 7	1,500	365			21	19	755,000
Tuesday	May 8	1,500	423			17	24	725,000
Wednesday	May 9	1,500	407			19	24	655,000
Thursday	May 10	1,500	385			9	13	464,000
Friday	May 11	1,500	563			26	29	979,000
Saturday	May 12	1,500	342			20	24	743,000
Sunday	May 13	400	175			9	12	364,000
Monday	May 14	1,500	333			13	15	673,000
Tuesday	May 15	1,500	262			6	8	315,000
Wednesday	May 16	1,400	529			19	23	764,000
Thursday	May 17	1,500	655			20	26	865,000
Total								11,152,000
Friday	May 18	1,500	527			25	28	776,000
Saturday	May 19	1,500	437			31	35	1,140,000
Sunday	May 20	1,250	533			26	30	870,000
Monday	May 21	1,250	477			22	29	886,000
Tuesday	May 22	1,250	391			19	21	720,000
Wednesday	May 23	1,250	311			13	15	433,000
Thursday	May 24	1,250	273			11	12	307,000
Friday	May 25	1,250	125			4	5	130,000
Saturday	May 26	1,250	125			3	3	75,000
Sunday	May 27	(*)	113			10	14	375,000
Monday	May 28		78			17	9	268,000
Tuesday	May 29		100			7	14	380,000
Wednesday	May 30		54			5	18	218,000
Thursday	May 31		45			2	2	50,000
Friday	June 1		75			9	11	288,000
Saturday	June 2		109			6	14	550,000
Sunday	June 3		83			4	10	226,000
Total								7,692,000
Monday †	June 4					2	4	85,000
Tuesday	June 5	115	23			5	9	240,000
Wednesday	June 6	115	27			2	2	45,000
Thursday	June 7	115	80					300,000
Friday	June 8	115	‡23					
Saturday	June 9							
Sunday	June 10	115	20			6	14	15,000
Monday	June 11	115	1				1	
Tuesday	June 12	115	57			20	37	
Wednesday	June 13	(*)						
Total								685,000
Grand total								21,850,000

* Seining discontinued. † June 4 to 11, seine belonging to United States Fish Commission, Fort Washington, Md. ‡ All females.

XXX.—REPORT OF OPERATIONS AT THE HAVRE DE GRACE SHAD-HATCHING STATION DURING PART OF THE SEASON OF 1883.

By Lieut. W. F. Low, U. S. N.

Table I.—*Record of temperature observations made at Battery Station, on the Susquehanna River, from April* 27, 1883, *to June* 3, 1883, *by Lieut. W. F. Low, U. S. N.*

Date.	Temperature at—								
	6 a. m.			12 m.			6 p. m.		
	Air.	Water.	Jars.	Air.	Water.	Jars.	Air.	Water.	Jars.
1883.									
April 27	......	......	......	......	......	......	58	51	56
April 28	64	50	53	62	53	55	56	53	55
April 29	43	50	53	43	50	53	51	52	54
April 30	47	50	55	61	52	55	52	55	56
May 1	47	52	57	58	53	54	54	55	54
May 2	44	53	55	63	57	57	64	58	58
May 3	49	56	58	65	57	60	66	61	60
May 4	56	58	62	68	60	61	66	63	63
May 5	50	60	62	51	59	60	56	60	62
May 6	58	60	62	60	62	62	62	59	62
May 7	54	61	63	64	62	63	66	64	64
May 8	62	63	63	74	64	64	74	66	67
May 9	62	64	65	72	65	66	66	66	66
May 10	54	64	64	74	67	67	76	68	69
May 11	66	67	68	70	67	68	70	68	69
May 12	56	67	66	60	66	66	64	69	68
May 13	60	65	67	67	67	66	68	68	69
May 14	50	65	65	65	63	64	56	63	64
May 15	58	63	64	70	65	65	68	67	66
May 16	52	61	63	61	62	62	63	65	65
May 17	48	61	62	60	64	63	62	67	66
May 18	54	63	64	68	66	65	76	68	67
May 19	56	64	65	72	67	66	70	70	68
May 20	55	66	67	64	67	68	70	68	68
May 21	56	67	68	52	67	67	66	68	68
May 22	61	68	67	64	67	67	60	68	69
May 23	50	65	66	56	65	65	54	64	65
May 24	51	62	63	67	64	64	69	64	65
May 25	59	63	63	75	64	64	71	65	65
May 30	62	67	68	69	67	67	66	69	69
May 31	69	68	69	72	69	69	72	70	70
June 1	59	67	68	70	68	69	70	70	72
June 2	62	69	69	72	70	70	66	70	71
June 3	60	68	69	72	69	70	70	70	71

TABLE II.—*Record of shad-hatching operations conducted at Battery Station, at the head of Chesapeake Bay, from April* 19, 1883, *to June* 1, 1883, *by Lieut. W. F. Low, U. S. N.*

Date.	Eggs obtained.	Loss of eggs.	Fish hatched.	Date of hatching.	Fish deposited in local waters.	Other disposition.	Date of deposit or transfer.	Remarks.
Apr. 19	25,000	25,000	....	....	....	....	....	
Apr. 20	30,000	2,000	28,000	May 2	28,000	....	May 4	
Apr. 21	75,000	25,000	50,000	May 2	50,000	....	May 4	
Apr. 28*	95,000	16,000	79,000	May 7	79,000	....	May 10	
Apr. 30	110,000	45,000	65,000	May 7	65,000	....	May 10	
May 1	40,000	5,000	35,000	May 8	35,000	....	May 11	
May 2	155,000	12,000	143,000	May 10	143,000	....	May 11	
May 3	180,000	20,000	160,000	May 10	160,000	....	May 12	
May 4	75,000	10,000	65,000	May 10	65,000	....	May 12	
May 5	240,000	28,000	212,000	May 12	212,000	....	May 13	
May 7	500,000	60,000	440,000	May 13	440,000	....	May 14	
May 8	200,000	24,000	176,000	May 15	176,000	....	May 16	
May 9	270,000	56,000	214,000	May 16	214,000	....	May 17	
May 10	175,000	50,000	125,000	May 18	125,000	....	May 19	
May 11	100,000	36,000	64,000	May 17	64,000	....	May 19	
May 12	180,000	39,000	141,000	May 19	141,000	....	May 20	
May 13	45,000	15,000	30,000	May 20	30,000	....	May 21	27,000 eggs from fish in pool; 25,000 eggs hatched successfully.
May 14	286,000	54,000	232,000	May 20	232,000	....	May 21	
May 15	32,000	3,000	29,000	May 21	29,000	....	May 22	
May 16	356,000	48,000	308,000	May 23	....	308,000	May 24	Pennsylvania Fish Commission.
May 17	323,500	27,000	296,500	May 24	296,500	....	May 25	Of a number of eggs taken from roe after shad was dressed and impregnated with milt from males in live box 50 per cent came up and 10 per cent hatched.
May 18	226,000	39,000	187,000	May 23	187,000	....	May 25	
May 19	1,000,000	180,000	820,000	May 24	820,000	....	May 26	55,000 eggs from shad that had been dead from one to one and one-half hours. 45,000 hatched successfully.
May 21	505,000	79,000	426,000	May 27	....	300,000	May 28	Pennsylvania Fish Commission.
						126,000	May 30	Fish Commission car No. 1.
May 22	468,000	72,000	396,000	May 28	....	396,000	May 30	Do.
May 23	237,000	34,000	203,000	May 29	....	203,000	May 30	Do.
May 24	149,000	9,000	140,000	May 30	....	140,000	June 2	H. E. Quinn.
May 25	65,000	5,000	60,000	May 31	....	60,000	June 2	Do.
May 28	30,000	5,000	25,000	June 3	25,000	....	June 4	
May 31	38,000	23,000	15,000	June 4	15,000	....	June 4	
June 1	153,000	33.000	120,000	June 4	120,000	....	June 4	

* April 22 to 27, inclusive, no operations.

XXXI.—NOTES ON EXPERIMENTS IN PENNING SHAD AND TAKING EGGS AT BATTERY STATION, HAVRE DE GRACE, MD., IN 1883.

By Frank N. Clark.

May 12, arrived at station at 12 noon. Found about 1,000,000 eggs and some fish in jars. Lieutenant Low had just sent seine out; it came in about 1 o'clock. The fish were transferred to the penning basin as usual and handled as carefully as the circumstances would permit. At 7 o'clock in the evening the fish in the basin were hauled in and examined. On opening some of the females most advanced and those that had been confined in the basin for several days, I found nothing but "slough" and blighted eggs, showing that the treatment of the fish had been unfavorable to a normal development of the eggs. Whether the trouble was caused by the fish being injured by handling or on account of being penned, I was unable to determine.

May 13, outside seine hauled at 6 p. m. All the fish in basin were handled again to-day. Found one good, ripe fish; the eggs came up well and were a prime lot. Think this fish was placed in basin yesterday. Eggs from another fish that was apparently ripe, looked clear, but on taking them and adding milt they did not come up, and were afterwards thrown away.

May 14, eggs taken from basin last evening look well. Net was laid out at 11 a. m. and landed at 2 p. m. Only 6 shad taken; not being such as I wanted to experiment with, I turned them over to the men's mess.

May 15, eggs in jar taken from fish in basin on the 13th are in good condition; are better eggs than those taken same night from gillers' boat. Noticed that some fish hatched from eggs taken previous to my arrival are not doing well in glass aquarium; seemed to be very feeble; think the eggs were not allowed sufficient volume and current of water to give normal development to the embryos. Seine put out at noon and taken in at 3 p. m. Put 8 females, nearly ripe, and 7 males in crate just outside of basin. Crate made of strips nailed to frame-work; strips placed 1½ inches apart, to allow water to flow freely through it; size, 16 feet long by 6 wide and 4 deep. Placed in the basin 8 females and 7 males from same catch and in apparently same condition as those in crate. With a view to giving fish in crate a better current of water the crate was towed 5 rods out and anchored.

May 17, eggs taken from female from basin on the 13th still looking well. Haul seine came in at 7 a. m. Put 16 females, nearly ripe, in the basin. Seine laid out at 3.30 p. m. and hauled in at 6 p. m. Caught 100 shad; one ripe female. Put 16 males and 11 females in crate.

May 18, eggs from basin, taken the 13th, are in excellent shape, 90 per cent good. Examined fish in crate at noon; they are doing well. Examined them again at 6 p. m.; still looking well. Seine was not hauled to-day. Of a few eggs taken from a shad after it had been dressed, about 10 per cent came up and were in good condition.

May 19, eggs in jar from fish from basin have begun to hatch. These are the first from the penned fish. The form of the fish is visible in some of the eggs taken yesterday from a dressed shad. Temperature at 2 p. m. of water in basin at north end, 69° F.; near east gate, 67°; at end of west pier, 66°. At 2 p. m. seine was hauled in basin, the fish handled very carefully, and 11 females, hard, returned; 15 males and 2 females were found ripe—1 with rotten eggs and the other with a portion of her eggs blighted and some of them looking fairly well, but on adding milt or water they did not come up. Fish in crate were overhauled at 2.30 p. m. Found 7 dead females nearly eaten up by eels; 3 were alive, but quite badly laden with fungus; eels had been at them. Males looking fairly. The 3 females that were alive were brought ashore and cut open. In 2 the spawn looked normal; in the other it did not. The 2 that were apparently all right would not have spawned, probably, for a week or longer. In the evening a female shad brought in by the gillers, out of water one hour, was used with a male from the crate and a good percentage of impregnation obtained. Later in the evening 2 females that had been caught one and one-half hours were stripped and the eggs, fertilized with a live milter from the crate, looked very well.

May 20, 3 live males still in the crate. Eggs taken yesterday from fish caught one and one-half hours are looking well. No eggs taken to-day. Two degrees difference in temperature of water at warmest place in basin and west end pier, 69° and 67°.

May 21, males in crate still alive. Seine hauled; landed at 8 p. m. Placed 3 females, nearly ripe, and 8 males in a large tank and gave them a constant supply of fresh water from the pump. At 10 p. m. the females were all dead, but the males were doing well.

May 22, 2 of the males in tank in poor condition this morning. Took them all out at noon; experiment of holding them in tanks a failure. One male left in crate. Divided the basin into two sections by placing a net across from north side of east gate to north side of west gate.

May 23, seine hauled; taken through gate into basin without handling the fish. Do not know how many fish were caught.

May 25, seine was not put out to-day. At 6 p. m. a haul of 32 fish was made in basin; these were from the lot hauled into basin through

gate on the 23d. Of this lot 17 females, hard, and 5 males were returned to the basin. Six females were found ripe; from 1 of these 35,000 good eggs were taken; from the others nothing but rotten eggs.

May 26, seine hauled; landed at 10.30. Found one spent shad, the first of the season. Did not put any fish in the basin.

June 1, seine hauled at 5 p. m. Put 40 females in basin and 8 males in crate. Fish apparently in better condition than any hitherto reserved for penning. In the evening, took 35,000 eggs from female brought in from gillers' boat, dead one hour, and fertilized them with male from crate. Eggs very good, better than any of the 153,000 brought in same evening from gillers' boats.

June 2, seine hauled; landed at 5 p. m.; very poor haul; did not put any fish in basin, but placed 4 males in crate. In the evening, hauled seine in basin and caught 35 fish; found 6 ripe females, but no good eggs; transferred remainder of fish to boat filled with water, and then taken across line of net extending from gate to gate and overturned, releasing fish in channel.

June 5, seine laid out early this morning; landed at 7.30 a. m. Caught 31 shad; put 7 males in crate and turned remainder of fish over to the men's mess. Lieutenant Low left the station to-day. Seine hauled at 8.30 p. m.; caught 51 shad, 8 ripe; took 200,000 eggs. Sent four men out to work the gillers' boats; they took 160,000 eggs; also brought in 4 female shad, from which 100,000 good eggs were obtained after fish had been dead one hour, using live males from the crate.

June 6, seine laid out at 7 p. m.; landed at 10 p. m. Caught 15 shad, 7 ripe; took 100,000 eggs from five, in the usual manner; took eggs from the other two, and fertilized by cutting open two males and emptying contents of milt sac into a pan, diluting with water, and pouring the mixture over the eggs. About 50 per cent of the eggs came up nicely. The males had been stripped in the usual manner a short time before being opened. Caught about 1,000 catfish in the seine. Had a boat fitted up for the purpose of carrying live fish to and from gillers' grounds; more especially for towing males out to the men working the gillers' boats, a great scarcity of milters being reported. Boat arranged with holes through sides, covered with netting; top of boat covered partly with boards and remaining portion with pieces of seine. In the evening 5 fish were placed in the boat and towed to the gillers near Havre de Grace light. These fish were supposed to be males, but three proved to be female shad. Seventy-five thousand eggs were taken from 3 ripe shad, using the 2 males towed out; these eggs were the best taken to-day. There were 20,000 taken this evening from other sources, making 195,000 for the day. Making arrangements for putting in a pound-net. Went out this afternoon to drive stakes, but tide was so low could not work launch.

June 7, wind blowing too hard this morning to drive stakes for

pound-net. Seine laid out at 7 a. m.; landed at 9.30. Caught 7 shad, none ripe, and great numbers of catfish. Put 2 male shad in crate and 5 females in basin. Eggs impregnated yesterday by cutting open the milters, all dead. Heavy storm about 4.30 p. m.; water very turbid. Did not lay out large seine this afternoon. Hauled seine in basin; caught 7 shad, 1 ripe; used male out of crate and got 30,000 good eggs. The female from which these eggs were obtained was one of the lot of 5 placed in the basin this morning. The 6 hard fish were returned to the basin. In the evening sent launch up towards Havre de Grace to see if gillers were out; only two out; one caught 1 shad and the other none. Wind blowing strong all day; muddy water first appeared outside of basin at 1 p. m.; inside of basin, seven hours later, 8 p. m., showing very conclusively that there is not a good change of water inside.

June 8, laid out large seine at 8.30; hauled in at 11 a. m.; caught 3 large rock, 600 pounds catfish, and 12 shad. Catfish turned over to men's mess; 1 spent shad salted; 10 female shad placed in the basin and 1 male in the crate. Drove some pound-net stakes to-day. Did not haul large seine in the evening, as men did not get back from gillers in time; there were 50,000 eggs taken from gillers' boats. Two men sent out with gill-net; caught 1 female shad.

June 9, laid out large seine at 9 a. m.; returned at 11.30 a. m. Caught 9 female shad, 2 of them spent; placed the 7 hard shad in basin; caught 400 pounds catfish and 1 bass; turned over to men's mess. No gillers out. No eggs taken to-day. Had 4 men at work setting pound stakes.

June 10, warmest day of season; temperature 87°; of water in jars 83°; water in basin, near inlet pipe to pump, 85°. Heavy shower at 9 p. m.

June 11, seine laid out at 9.45 a. m.; landed at noon. Caught a few catfish and 6 female shad; 1 was ripe, 1 spent, and 4 turned into the basin. About noon a strong breeze sprang up from WNW. and by 3 p. m. was blowing a gale. No gillers out and no eggs taken.

June 12, sent men out to lift pound-net and straighten stakes. Caught some fish offal, but no shad. Hauled in large seine at 1 p. m. Caught 2 unripe female shad, and 1 male shad; placed the former in basin and the latter in crate. At 7 p. m. hauled seine in basin and caught 30 shad; 9 females ripe, but eggs were rotten.

June 13, landed seine at 1.30 a. m.; caught 3 shad; 1 ripe but eggs rotten, 1 hard, and 1 male. Seine laid out again at 11 a. m., and landed at 1.45 p. m.; caught some catfish, perch, and 1 spent shad.

June 14, very low tide; could not lay seine in consequence.

June 15, laid seine at 12.30 a. m., landed at 4 a. m. Caught 3 shad and a number of rockfish. Two of the shad were males and 1 a female, with worthless eggs. Hauled in seine again at 3.30 p. m. Caught some

catfish and rockfish but no shad. Current down river so strong had to lay seine in NE. direction from battery on flood tide.

June 16, landed seine at 4.30 p. m. Some rock and catfish but no shad. Had to lay seine in NE. direction from battery, on high tide, on account of strong current. Wind SE. veering to SW. later, with slight rain.

June 18, seine hauled in at 6 p. m. Some rock and catfish, and 2 shad, 1 spent and 1 hard. Took up pound-net to day.

June 19, seine brought in at 10 a. m. Seine badly rolled on account of grass and no fish caught. Spread seine out on grass to dry. Ropes and quarter-chains stretched on buildings for same purpose. Woodram's men working on apron in basin. Pound-net placed in store-room.

June 20, temporary force discharged.

June 21, seine stored in SW. room of men's quarters in hatching house.

In all, several hundred shad were placed in the basin. Good eggs were taken from only 3 fish, and these had been held not more than forty-eight hours, being so far advanced when caught that the conditions of confinement could have had little or no effect on the eggs, even if such conditions were adverse to a normal development of immature spawn. The results of the experiments, though negative, should not, however, be regarded as decisive, as the circumstances were not such as to insure a healthy condition of the fish, on which the normal development of the eggs must largely depend. It is very evident that there was an insufficient current or change of water throughout the basin, except between the gates. The fact that turbid water outside the basin did not find its way inside for nearly eight hours leaves no room for doubt on this point. This difficulty, however, can be largely overcome by providing additional openings, through the north pier, thus allowing free entrance and exit to the tide currents, both ebb and flow. An arm extending from each opening will divert to the basin the currents deflected by the apex of the pier. It would also be well to divide the basin into four sections, by laying seines between the east and west pier; one for the males and three for females of different stages of advancement. The apron extending from the southwest gate to the north pier provides an easy landing for the seine hauls from each section. By this arrangement unnecessary handling or disturbance of the fish least advanced can be avoided.

The experiments show very conclusively that female shad are extremely sensitive to the least interference with nature's methods of reproduction; and that under certain circumstances such interference results in impairment of that function. Very different results, however, may be obtained under more favorable circumstances. There is still considerable room for experiment in this direction. But should all efforts to hold female shad in confinement with a view to saving their

eggs prove futile, thousands of eggs that would otherwise be lost can be saved from the gillers' boats and the haul seine, simply by holding a reserve stock of males in the basin and towing them in a crate or car to the gillers' grounds, or by bringing the females to the basin, either of which methods is entirely practicable. The location and facilities of the station are all that could be desired for this purpose, and there is invariably a scarcity of male fish from about the 25th of May to the close of the season.

Record of shad-hatching operations conducted by Frank N. Clark, at Havre de Grace, Md., under the direction of the United States Fish Commission, from June 4 to June 11, 1883.

Date of receiving eggs.	Date of hatching eggs.	Number of eggs obtained.	Condition of eggs obtained.	Number of fish hatched.	Per cent of eggs hatched.	Disposition of the fry.
1883.	1883.					
June 4, 11 p. m.	June 7	100, 000	Poor	47, 000	47	To H. E. Quinn.
June 4, 11 p. m.	June 7	100, 000	Good	85, 000	85	Do.
June 4, 11 p. m.	June 7	90, 500	Good	70, 000	$77\frac{1}{3}$	To H. E. Quinn.
June 4, 11 p. m.	June 7	85, 000	Good	68, 000	80	Planted in bay.
June 4, 11 p. m.	....	30, 000	All died	....	....	
June 5, 9 p. m.	June 8	95, 000	Good	80, 000	$84\frac{4}{19}$	Planted in bay.
June 5, 11 p. m.	June 8	86, 000	Good	65, 000	$75\frac{5}{8}$	
June 5, 11 p. m.	June 8	95, 000	Good	77, 000	$81\frac{1}{19}$	Planted in bay.
June 5, 11 p. m.	June 8	42, 000	Fair	25, 000	$59\frac{11}{21}$	To H. E. Quinn.
June 5, 11 p. m.	June 8	26, 000	Good	20, 000	$76\frac{12}{13}$	Do.
June 5, 9 p. m.	June 8	92, 000	Good	80, 000	$86\frac{22}{23}$	Planted in bay.
June 6, 10 p. m.	....	93, 500	Fair	55, 500	$59\frac{167}{187}$	
June 6, 10.30 p. m.	....	101, 000	Poor	60, 000	$59\frac{41}{101}$	
June 7, 8 p. m.	....	30, 000	Good	20, 000	$66\frac{2}{3}$	
June 8, 10.30 p. m.	June 11	30, 000	Poor	16, 000	$53\frac{1}{3}$	Planted in bay.

XXXII.—REPORT OF THE DIVISION OF DISTRIBUTION OF THE UNITED STATES FISH COMMISSION FOR THE YEAR 1883.

By Marshall McDonald.

I.—OFFICE SERVICE.

All applications made to the United States Fish Commission for fish or eggs go to the division of distribution. Here they are filed, indexed, and all particulars embodied in the applications entered into the serial register, which constitutes a part of the permanent records of the office. The action taken upon each is also entered in the register, so that this furnishes a complete history of every application reaching the office of the United States Fish Commission. All applications are acknowledged by a postal card informing the applicant when to expect his fish.

In the register the applications are entered seriatim in the order in which they are received. For convenience of reference and to facilitate the distribution, the applications are classified by States and counties; all the counties in the same Congressional district are grouped together to form what are known as Congressional lists. These are always ready for inspection or reference, and a Congressional Representative can learn at a glance the number and names of all applicants for carp in his district and the status of their applications.

When the date of distribution to a particular section of the country is determined upon, information is mailed to each applicant who is to receive fish, of the time at which to expect them and the destination to which they will be sent.

For the guidance of the messengers engaged in making the distribution, transcripts of the Congressional lists are made, and specific instructions are prepared prescribing the route to be traversed, the points from which distribution by express is to be made, and regulating all the details of the work.

For each State a central point for distribution is selected, to which the fish are sent in charge of messengers. Preliminary to the distribution the messenger in charge sends to each applicant a postal notice, informing him at what date the fish will be forwarded from the depot or center of distribution, and to what express office they will be consigned. The shipping tag attached to each pail is doubled, and in the fold is placed a blank postal receipt, to be signed and mailed to the office of the Commission. Usually this is promptly done, and by the

time a messenger gets back to headquarters most of the receipts showing the safe delivery of the fish have reached the files of the division of distribution.

The total number of applications for carp filed since the inauguration of the work of distribution is about 25,000. These are numbered seriatim in the order of date of reception, and the receipts are numbered to correspond with the applications to which they belong.

The total number of applications filed during the year 1883 was 10,060, classified by months, as follows:

January, 800; February, 820; March, 860; April, 800; May, 200; June, 500; July, 580; August, 560; September, 1,380; October, 1,920; November, 800; December, 840. Total, 10,060.

The preparation of the correspondence relating to distribution, or incidental to it, and the replies to the numerous and diversified inquiries relating to fish culture in general, is also one of the duties of the chief of the division of distribution.

Much of the correspondence relates to routine matters, and is prepared by Mr. J. J. O'Connor, the very efficient corresponding clerk in the division of distribution.

Much of it, however, relates to the general administration of the division or other matters necessitating the personal attention of the chief of the division, and in many cases much time is consumed in preparing the necessary data upon which to base satisfactory replies.

Under the instructions of the Commissioner, the chief of the division of distribution is charged with the direction and control of *the Central Station* of the Commission, in Washington, and of the trout-breeding station at Wytheville, Va.

The former, if its importance is to be measured by the results obtained, is the principal station for the production of shad fry for transplanting to new or depleted waters, while the latter is the only station devoted to the raising of the rainbow trout for transplanting to suitable streams in the Atlantic and Gulf States.

Separate reports for each station will be found elsewhere in this volume.

II.—CAR AND MESSENGER SERVICE.

After the completion of the carp distribution of 1882, Fish Commission cars Nos. 1 and 2 were sent to the shops and were thoroughly overhauled and put in complete repair in preparation for the spring work. Early in February car No. 1, in charge of J. F. Ellis, was put in commission and ordered to Northville, Mich., to report to F. N. Clark, superintendent of Northville Station, and make the distribution of whitefish fry from there. An account of this work and a tabular summary of the distribution will be found in the report of the United States Fish Commission for 1882.

Car No. 1 was held in reserve for the shad work. This was delayed for ten days or more beyond the usual period, in consequence of the

abnormally low temperature which prevailed in the Potomac River, the effect being to retard greatly the ripening of the fish. The first messenger shipment was made to the Monocacy, a tributary of the Potomac, on April the 30th.

The first car shipment, consisting of 238,000 shad and 4,300,000 herring, was made May 10; the shad being planted in the Scioto River at Chillicothe, and the herring in the Ohio River in the vicinity of Cincinnati.

The second trip of car No. 2 was with 1,350,000 shad for James River. These were planted in fine condition in the river several miles above Bosher's Dam. Dr. W. M. Hudson, the Commissioner of Fisheries for Connecticut, accompanied the car as the guest of the Commission, he having been designated by the United States Commissioner to inspect and make a report upon the working of the McDonald fishway at Bosher's Dam.

Car No. 2 completed the white fish distribution May 10 and shortly afterwards reported at headquarters in Washington, in readiness for the shad work.

Being fitted with the necessary machinery and appliances for maintaining a regular circulation of water, it was determined to test its efficiency in shad work. The entire shipment of 1,200,000 shad destined for the Savannah and the Congaree Rivers was divided, one-half being placed in ordinary transportation cans, the other in the automatic circulating cans. The fish in the latter proved a total loss. This experiment, while discouraging, does not give occasion to doubt eventual success, when we shall have studied and better understand the conditions upon which success depends. An interesting feature of the season's work is the large plant of herring (4,300,000) made in the Ohio in the vicinity of Cincinnati. This and the plant of 2,000,000 made in the Colorado River of Texas, in 1882, would seem sufficient to test the probability of acclimating this important species in the rivers tributary to the Gulf of Mexico.

The total number of shad and herring fry distributed through Central Station for the season of 1883 is as follows:

	Shad.	Herring.
Susquehanna River:		
Battery Station	1,275,000	....
Potomac River:		
Fish Hawk Station	1,684,000	6,850,000
Central Station	9,449,000	....
Total	12,408,000	6,850,000

A tabular summary of the distribution of shad and herring for the season of 1882 will be found in Table I. This summary is based upon the reports of messengers in charge of shipments, and gives the number actually planted. The discrepancies between Table I and the tables of distribution, given under the head of propagation in the report of Central Station, indicate the losses in transportation.

TABLE 1.—*SHAD AND HERRING FRY DEPOSITED IN WATERS OF THE UNITED STATES DURING THE SEASON OF* 1883.

Date.	Number of shad.	Number of herring.	Stream.	Point of deposit.	Where hatched.	Messenger in charge.
Apr. 30	250,000		Monocacy	Frederick City Junction, Md	Central Station	Frank L. Donnelly.
May 3	175,000		do	do	do	Do.
6	111,000		Potomac	Little Falls, Md	do	Joseph Mace.
10	228,000		Sciota	Chillicothe, Ohio	Central Station and steamer Fish Hawk	G. H. H. Moore.
10		4,300,000	Ohio	Cincinnati, Ohio	Steamer Fish Hawk	Do.
14	410,000		Potomac	Little Falls, Md	Central Station	Joseph Mace.
14	300,000		Shenandoah	Strasburg, Va	do	Harry Quinn.
15	247,000		Potomac	Mouth of Savage River, Md	do	G. G. Davenport.
16	277,000		Dan	Danville, Va	do	Harry Quinn.
17	1,360,000		James	Richmond, Va	do	G. H. H. Moore.
17	175,000		Shenandoah	Strasburg, Va	Steamer Fish Hawk	G. G. Davenport.
18	175,000		Patuxent	Laurel, Md	do	Gus Stewart.
18		1,700,000	do	do	do	Do.
19	552,000		Illinois	Peoria, Ill	Central Station	G. H. H. Moore.
19	552,000		do	Havana, Ill	do	Do.
19		850,000	do	Peoria, Ill	Steamer Fish Hawk	Do.
19	250,000		Holston	Union Depot, Chattanooga, Tenn	Central Station and steamer Fish Hawk	Harry Quinn.
22	250,000		Savannah	Tugalo, Ga	Central Station	G. G. Davenport.
22	300,000		Waters of South Carolina	Columbia, S. C	do	C. J. Huske.
23	150,000		James	Lynchburg, Va	Steamer Fish Hawk	William F. Page.
24	300,000		Potomac	Cumberland, Md	do	Harry Quinn.
25	1,500,000		Hudson	Troy, N. Y	Central Station and steamer Fish Hawk	G. H. H. Moore.
26	329,000		Potomac	Cumberland, Md	Central Station	Harry Quinn.
27	300,000		South	Waynesboro', Va	do	G. G. Davenport.
28	150,000		Ohio	Marietta, Ohio	Steamer Fish Hawk	Harry Quinn.
29	800,000		Savannah	Near Toccoa City, Ga	Central Station	J. Frank Ellis.
29	350,000		Congaree	Columbia, S. C	do	Do.
31	232,000		Kentucky	High Bridge, Ky	Central and Battery Stations	G. H. H. Moore.
31	230,000		do	Frankfort, Ky	do	Do.
31	230,000		Green	Munfordville, Ky	do	Do.
31	230,000		Salt	Shepherdsville, Ky	do	Do.
31	230,000		Barren	Bowling Green, Ky	do	Do.
June 4	200,000		Potomac	South Branch Depot, West Virginia	Battery Station	Harry Quinn.
4	105,000		Oconee	Milledgeville, Ga	Central Station	J. Frank Ellis.
4	350,000		Ocmulgee	Macon, Ga	do	Do.
8	270,000		Bayou	Pass Manchac, La	do	G. H. H. Moore.
8	270,000		do	La Fourche, La	do	Do.
8	270,000		do	Vermillion, La	do	Do.
9	50,000		Smokey Hill	Near Junction City, Kans	Battery Station	Harry Quinn.
9	50,000		Republican	do	do	Do.
13	200,000		Hudson	Van Wagner, N. Y	Central and Battery Stations	William F. Page.
	12,408,000	6,850,000				

The last car shipment of shad was made June 8 by car No. 1, in charge of G. H. H. Moore, to streams in Louisiana, 270,000 fry being deposited in Pass Manchac, a bayou draining the waters of Lake Maurepas into Lake Pontchartrain, and a like number in Bayou La Fourche and Vermilion River.

The work of shad distribution closed with a messenger shipment of 200,000 fry to the Hudson River. These were planted in good condition at Van Wagner, N. Y., by Mr. W. F. Page, the messenger in charge.

Upon the completion of the shad distribution, the Fish Commission cars Nos. 1 and 2 were, as usual, refitted and repaired so as to be ready for the opening of the carp work in October, and the messenger force furloughed without pay, subject to call when needed.

CARP DISTRIBUTION OF 1883.

Preparation for this began October 21, J. F. Ellis and G. H. H. Moore, messengers in charge, being ordered to duty, and directed to equip their cars in readiness for immediate service.

The actual work of distribution did not begin, however, until the last of October, in consequence of the delay in drawing the ponds. The first shipment was made October 30, car No. 2, in charge of J. F. Ellis, being dispatched to Louisville with 15,000 carp for the supply of applicants in Kentucky.

The distribution by express was made from the Exposition grounds in compliance with the request of the Commissioners, who desired the car and the methods of distribution to be made a part of the Government exhibit.

Apprehending an early closure of the waters in the Northwest by ice, and consequent interruption of the work, should there be delay in sending the carp, car No. 1, in charge of G. H. H. Moore, was dispatched November 5 with 20,000 carp for the supply of all applicants in Iowa, Wisconsin, Minnesota, Dakota, Oregon, and Washington Territory. The liberal concession of free transportation over the line of the Northern Pacific between Saint Paul, Minn., and Portland, Oreg., which was so generously afforded by Mr. Villard, the president, made possible this work, so important in the interests of fish culture.

The departure of car No. 1 for the supply of the Northwest and North Pacific coast States was followed November 8 by the dispatch of car No. 2 with 13,000 fish for the supply of applicants in Canada, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, and Northern New Jersey. The distribution to New York and New Jersey was made by express from New York City, Mr. E. G. Blackford, commissioner of fisheries for New York, as usual, affording every facility for the convenience of the work. The distribution to the Northeastern States and Canada was made by express from Boston.

The experience of several seasons having demonstrated that a satisfactory distribution of carp could be made only in the fall and early

winter the work was planned so as to bring it to a close by the 1st of January.

To accomplish this, recourse was had to express shipments on a large scale with the result of reducing considerably the cost of the distribution.

On November 8, 15,000 carp, destined for the supply of applicants in Illinois, were forwarded by express from Washington to Dr. Bartlett, State commissioner of fisheries at Quincy, Ill. Mr. Newton Simmons, messenger, accompanied the shipment to see that the crates were properly handled in transferring. The fish received no change of water en route, and reached their destination in fine condition. The distribution to applicants was made through the agency of Dr. Bartlett, the State commissioner of Illinois.

This movement of 15,000 carp a distance of 1,000 miles in charge of a single messenger forcibly illustrates the improvement in methods of transportation introduced since 1881. By the methods in vogue prior to that date it would have required ten messenger shipments to have accomplished the same work, and would have involved tenfold the cost.

On November 14, 5,000 carp were forwarded by express to Indianapolis, for the supply of applicants in Indiana. Mr. Simmons was instructed by telegram to meet the fish at that point, and after sending the usual messenger notices in advance to make the distribution by express. This being accomplished, he was ordered to Columbus, Ohio, to await the arrival of the carp for the supply of applicants in Ohio and Michigan. On November 20 the 5,000 carp required for this purpose were forwarded by express. They arrived at Columbus in good condition and a satisfactory distribution was shortly accomplished. The total number of fish distributed to the four States above named was 24,000, equal in number to the entire crop of 1880, and this work was accomplished at little more than the cost of a single messenger shipment of 1,500 fish made under the system of distribution employed prior to 1881.

On November 13 car No. 2, having completed the Northeastern distribution, was dispatched with 17,000 carp for the supply of applicants in Kansas, Nebraska, Colorado, Utah, Wyoming, Montana, Idaho, Nevada, and California.

On December 4 car No. 1, having completed the distribution along the line of the Northern Pacific, was sent with 17,000 carp for the supply of applicants in Arizona, Arkansas, Indian Territory, Louisiana, Mississippi, Missouri, New Mexico, Tennessee, and Texas.

On December 7 a depot of distribution was established at Atlanta, Ga., for the supply of applicants in Alabama, Georgia, and Florida. Mr. F. L. Donnelly was placed in charge of the work, the distribution to applicants being made by express from Atlanta. To supply applicants in North Carolina and South Carolina carp were sent in bulk to Raleigh and Columbia, and delivered to the State commissioners, S. G. Worth and C. J. Huske. The distribution was made by them in accord-

ance with lists furnished from the office of the United States Fish Commission. The States of Virginia, West Virginia, Maryland, Pennsylvania, and Southern New Jersey were supplied by express from Washington. Details of the carp distribution for 1883 will be found in Table II.

A review of this gives as the result of the season's work the following:

TABLE II.—*SUMMARY OF CARP DISTRIBUTED IN THE UNITED STATES AND CANADA DURING THE YEAR* 1883.

[Average distance of applicants from Washington, 895 miles.]

State or Territory.	Number of Congressional districts supplied.	Number of counties.	Number of applicants.	Number of fish.	Point of distribution.	Date of distribution.	Messenger in charge.
Alabama	8	41	168	2,100	Birmingham, Ala	1884. Jan. 3	F. L. Donnelly.
Arizona	....	5	14	274	Yuma, Ariz	1883. Dec. 4	George H. H. Moore.
Arkansas	4	16	70	1,154	Saint Louis, Mo	Dec. 4	Do.
California	4	12	18	337	San Francisco, Cal	Nov. 13	J. F. Ellis.
Colorado	...	10	33	655	Denver, Colo	Nov. 13	Do.
Connecticut	4	8	41	850	Boston, Mass	Nov. 8	Do.
Dakota	....	18	36	1,151	Saint Paul, Minn	Nov. 5	George H. H. Moore.
Delaware	....	3	5	445	Washington, D. C	Nov. 24	Express company.
District of Columbia	....	......	7	82	...do	1883–'84	Individual orders.
Florida	2	13	38	550	Atlanta, Ga	1883. Dec. 7	F. L. Donnelly.
Georgia	9	64	311	6,045	...do	Dec. 7	Do.
Idaho	..	4	9	183	Ogden, Utah	Nov. 13	J. F. Ellis.
Illinois	17	73	467	15,000	Quincy, Ill	Nov. 8	Newton Simmons.
Indiana	13	58	220	4,392	Indianapolis, Ind	Nov. 14	Do.
Indian T	..	3	3	80	Hillsborough, Tex	Dec. 4	George H. H. Moore.
Iowa	11	66	172	5,000	Anamosa, Iowa	Nov. 5	Do.
Kansas	3	70	371	7,652	Topeka, Kans	Nov. 15	J. F. Ellis.
Kentucky	11	48	193	15,040	Louisville, Ky	Oct. 30	Do.
Louisiana	5	17	41	788	New Orleans, La	Dec. 4	George H. H. Moore.
Maine	....	8	12	252	Boston, Mass	Nov. 8	J. F. Ellis.
Maryland	6	14	63	3,182	Washington, D. C	Nov. 20	Express company.
Massachusetts	12	8	16	4,300	Boston, Mass	Nov. 8	J. F. Ellis.
Michigan	10	28	41	467	Columbus, Ohio	Nov. 20	Newton Simmons.
Minnesota	4	19	31	6,650	Saint Paul, Minn	Nov. 5	George H. H. Moore.
Mississippi	6	42	194	2,878	Jackson, Miss	Dec. 4	Do.
Missouri	14	36	99	1,580	Saint Louis, Mo	Dec. 4	Do.
Montana	....	5	7	300	Ogden, Utah	Nov. 13	J. F. Ellis.
Nebraska	3	14	26	2,320	Omaha, Nebr	Nov. 13	Do.
Nevada	....	13	46	2,285	Belmont, Nev	Nov. 13	Do.
New Hampshire	2	5	10	2,000	Boston, Mass	Nov. 13	Do.
New Jersey	7	20	62	1,041	Washington, D. C	1883–'84	Express company.
New Mexico	..	7	12	199	Deming, N. Mex	1883. Dec. 4	George H. H. Moore.
New York	30	36	113	4,290	New York City, N. Y	Nov. 8	J. F. Ellis.
North Carolina	8	69	978	15,313	Raleigh, N. C	Nov. 23	S. G. Worth.
Ohio	20	68	328	4,000	Columbus, Ohio	Nov. 20	Newton Simmons.
Oregon	....	18	107	4,265	Portland, Oreg	Nov. 5	George H. H. Moore.
Pennsylvania	26	54	384	5,783	Washington, D. C	Nov. 16	Express company.
Rhode Island	1	1	2	32	Boston, Mass	Nov. 8	J. F. Ellis.
South Carolina	7	32	764	15,389	Columbia, S. C	Nov. 12	C. J. Huske.
Tennessee	11	57	284	3,959	Milan, Tenn	Dec. 4	George H. H. Moore.
Texas	11	73	435	5,790	Dallas and other points.	Dec. 4	Do.
Utah	....	17	93	2,133	Salt Lake City, Utah	Nov. 13	J. F. Ellis.
Vermont	2	10	32	1,441	Boston, Mass	Nov. 8	Do.
Virginia	9	73	492	6,222	Washington, D. C	Nov. 5	Express company.
Washington	..	11	47	1,616	Portland, Oreg	Nov. 5	George H. H. Moore.
West Virginia	4	19	67	815	Washington, D. C	Nov. 20	Express company.
Wisconsin	8	17	26	1,060	Saint Paul, Minn	Nov. 5	George H. H. Moore.
Wyoming	....	5	27	560	Laramie City, Wyo	Nov. 13	J. F. Ellis.
Canada	....	....	1	100	New York City, N. Y	Nov. 14	Do.
Total	292	1,308	7,015	162,000			

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

ALABAMA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	2	6	63
2	8	34	365
3	7	30	308
4	5	31	321
5	6	15	165
6	1	1	11
7	9	36	375
8	3	9	120
Unaccounted for			312
Total	41	168	2,100

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Choctaw	2	27
	Marengo	4	30
2	Baldwin	1	10
	Butler	2	10
	Conecuh	5	50
	Crenshaw	1	16
	Covington	1	20
	Escambia	1	10
	Montgomery	17	174
	Pike	6	66
3	Barbour	5	50
	Bullock	13	142
	Dale	8	77
	Geneva	1	9
3—Cont'd	Henry	1	10
	Lee	5	50
	Russell	3	30
4	Dallas	6	60
	Hale	9	91
	Lowndes	1	20
	Perry	14	140
	Wilcox	1	10
5	Chambers	4	40
	Clay	2	20
	Coosa	2	14
	Elmore	3	40
	Macon	1	10
	Tallapoosa	3	41
6	Greene	1	11
7	Blount	5	60
	Calhoun	16	158
	Cherokee	1	10
	Cleburne	6	80
	Etowah	1	9
	Randolph	4	30
	Saint Clair	1	9
	Shelby	1	10
	Talladega	1	9
8	Lauderdale	1	10
	Lawrence	3	30
	Madison	5	80
Total		168	1,788
Number of fish sent to be distributed in the State for which no returns have yet been made			312
Grand total		168	2,100

ARIZONA.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	5	14	274
Total	5	14	274

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Apache	1	20
	Cochise	1	20
	Maricopa	9	180
	Pima	2	34
	Yuma	1	20
Total		14	274

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

ARKANSAS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	1	1	15
2	8	55	865
3	5	8	174
4	2	6	100
Total	16	70	1,154

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Phillips	1	15
2	Columbia	1	10
	Hempstead	17	281
	Hot Spring	1	15
	Howard	7	165
	Nevada	7	93
	Ouachita	6	95
	Sevier	6	90
	Union	10	116
3	Clark	3	60
	Garland	1	15
	Pulaski	1	20
	Sebastian	1	15
	Yell	2	64
4	Benton	4	80
	Boone	2	20
Total		70	1,154

CALIFORNIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	1	4	80
2	2	2	45
3	3	6	103
4	6	6	109
Total	12	18	337

Congressional district.	Counties.	No. of applicants.	No. of fish.
1	San Francisco	4	80
2	Alameda	1	20
	Contra Costa	1	25
3	Colusa	2	38
	Lassen	3	60
	Plumas	1	5
4	Los Angeles	1	20
	Merced	1	20
	Santa Barbara	1	20
	Santa Clara	1	20
	Santa Cruz	1	20
	Ventura	1	9
Total		18	337

COLORADO.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	10	33	655
Total	10	33	655

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Arapahoe	19	380
	Bent	1	20
	Elbert	1	22
	El Paso	2	43
	Huerfano	1	20
	Jefferson	3	60
	Larimer	2	40
	Las Animas	1	7
	Pueblo	1	23
	Weld	2	40
Total		33	655

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

CONNECTICUT.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	2	8	190
2	2	7	140
3	2	6	120
4	2	20	400
Total	8	41	850

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Hartford	4	110
	Tolland	4	80
2	Middlesex	1	20
	New Haven	6	120
3	New London	2	40
	Windham	4	80
4	Fairfield	15	300
	Litchfield	5	100
Total		41	850

DAKOTA.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	18	36	1,151
Total	18	36	1,151

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Beadle	1	6
	Brule	3	77
	Cass	1	50
	Custer	1	20
	Day	7	310
	Douglas	1	50
	Hanson	1	18
	Hughes	2	100
	Kidder	2	70
	Kingsbury	1	25
	Lake	1	20
	Lawrence	5	130
	Miner	2	40
	Nelson	1	10
	Pennington	4	100
	Richland	1	50
	Stutsman	1	50
	Yankton	1	25
Total		36	1,151

DELAWARE.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	3	5	45
Unaccounted for			400
Total	3	5	445

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Kent	3	20
	New Castle	1	8
	Sussex	1	8
Total		5	45
Number of fish shipped to State Commissioner for distribution unaccounted for			400
Grand total		5	445

DISTRICT OF COLUMBIA.

Number of applicants	7
Number of fish	82

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

FLORIDA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	4	80
2	9	34	470
Total	13	38	550

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Gadsden	1	20
	Hernando	1	20
	Levy	1	20
	Polk	1	20
2	Alachua	3	23
	Baker	1	12
	Brevard	1	5
	Duval	4	80
	Marion	3	60
	Orange	15	150
	Putnam	1	20
	Sumter	4	80
	Volusia	2	40
Total		38	550

GEORGIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	8	10	150
2	6	14	210
3	5	20	305
4	8	40	581
5	8	78	1,173
6	7	35	451
7	7	48	732
8	7	32	485
9	8	34	512
Unaccounted for	......	......	1,446
Total	64	311	6,045

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Appling	1	15
	Bryan	1	15
	Bulloch	1	15
	Burke	1	13
	Chatham	1	22
	Clinch	1	15
	Emanuel	3	45
	Wayne	1	10
2	Baker	1	15
	Brooks	7	105
	Clay	......	......
	Decatur	4	60
	Early	1	15
	Worth	1	15
8	Coffee	8	120
	Dodge	3	45
	Dooly	6	90
	Macon	2	40
	Taylor	1	10
4	Campbell	8	120
	Carroll	6	90
	Chattahoochee	2	30
	Coweta	10	150
	Douglas	3	30
	Harris	7	63
4—Cont'd	Talbot	2	38
	Troup	2	60
5	Baldwin	32	485
	Bibb	2	25
	Butts	2	33
	Laurens	3	45
	Newton	4	60
	Rockdale	1	15
	Walton	18	270
	Wilkinson	16	240
6	Clayton	1	15
	Crawford	2	30
	De Kalb	15	150
	Fulton	7	105
	Milton	1	20
	Pike	8	120
	Upson	1	11
7	Bartow	8	140
	Catoosa	6	90
	Chattooga	1	7
	Cherokee	8	120
	Cobb	12	180
	Floyd	8	120
	Gordon	5	75
8	Columbia	6	90
	Elbert	2	30
	Glascock	2	30
	Greene	12	180
	Hancock	7	105
	Oglethorpe	2	40
	Wilkes	1	10
9	Banks	3	45
	Clarke	3	45
	Forsyth	3	47
	Franklin	6	90
	Gwinnett	9	135
	Habersham	2	30
	Hall	7	105
	Rabun	1	15
Total		311	4,599
Number of fish sent out for distribution in State for which no returns have yet been made		......	1,440
Grand total		311	6,045

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

IDAHO.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	4	9	183
Total	4	9	183

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Ada	4	80
	Alturas	1	23
	Idaho	1	20
	Oneida	3	60
Total		9	183

ILLINOIS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	1	16	320
5	3	25	541
6	2	7	140
7	4	21	440
8	4	26	620
9	5	13	260
10	4	26	540
11	6	34	680
12	6	82	1,682
13	5	27	540
14	2	3	60
15	4	19	380
16	6	43	890
17	5	35	720
18	5	45	940
19	7	22	440
20	4	23	460
Number of fish unaccounted for	......	......	5,347
Total	73	467	15,000

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Cook	16	320
5	De Kalb	4	80
	Kane	20	441
	McHenry	1	20
6	Ogle	5	100
	Stephenson	2	40
7	Bureau	12	240
	Henry	5	120
	Lee	1	20
	Whiteside	3	60
8	Du Page	10	200
	Kendall	1	20
	La Salle	10	280
	Will	5	120
9	Iroquois	6	120
	Kankakee	2	40
	Livingston	2	40
	Marshall	2	40
	Woodford	1	20
10	Fulton	6	120
	Knox	6	120
	Peoria	12	240
	Stark	2	60
11	Hancock	10	200
	Henderson	2	40
	McDonough	8	160
11—Cont'd	Mercer	1	20
	Schuyler	2	40
	Warren	11	220
12	Adams	55	1,100
	Brown	1	20
	Cass	5	142
	Greene	2	40
	Pike	17	340
	Scott	2	40
13	Christian	2	40
	Mason	3	60
	Morgan	1	20
	Sangamon	12	240
	Tazewell	9	180
14	McLean	1	20
	Piatt	2	40
15	Champaign	6	120
	Coles	2	40
	Douglas	1	20
	Vermillion	10	200
16	Clark	4	80
	Clay	4	100
	Cumberland	8	160
	Jasper	16	320
	Lawrence	5	110
	Richland	6	120
17	Effingham	3	60
	Macoupin	18	360
	Montgomery	1	20
	Moultrie	3	80
	Shelby	10	200
18	Bond	6	120
	Madison	7	140
	Monroe	4	80
	Saint Clair	13	300
	Washington	15	300
19	Clinton	4	80
	Franklin	4	80
	Hamilton	5	100
	Jefferson	2	40
	Marion	3	60
	Saline	1	20
	White	3	60
20	Johnson	1	20
	Perry	9	180
	Randolph	12	240
	Union	1	20
Total		467	9,653
Number of fish shipped to State commissioner for distribution unaccounted for		......	5,347
Grand total		467	15,000

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

INDIANA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	2	2	26
2	5	11	240
3	4	18	360
4	7	23	460
5	5	17	340
6	6	50	1,000
7	3	16	320
8	5	12	240
9	4	6	120
10	7	38	760
11	4	9	180
12	3	10	200
13	3	8	146
Total	58	220	4,392

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Gibson	1	16
	Posey	1	10
2	Du Bois	3	60
	Knox	4	100
	Lawrence	2	40
	Orange	1	20
	Sullivan	1	20
3	Clark	3	60
	Floyd	3	60
	Harrison	10	200
	Jackson	2	40
4	Dearborn	5	100
	Decatur	2	40
	Franklin	2	40
	Jefferson	5	100
	Ripley	6	120
	Switzerland	1	20
4—Cont'd	Union	2	40
5	Bartholomew	1	20
	Kendricks	5	100
	Johnson	1	20
	Morgan	3	60
	Putnam	7	140
6	Delaware	1	20
	Fayette	20	400
	Henry	2	40
	Randolph	5	100
	Rush	4	80
	Wayne	18	360
7	Hancock	1	20
	Marion	7	140
	Shelby	8	160
8	Clay	2	40
	Montgomery	3	60
	Vermillion	3	60
	Vigo	3	60
	Warren	1	20
9	Clinton	1	20
	Hamilton	2	40
	Madison	1	20
	Tippecanoe	2	40
10	Cass	5	100
	Carroll	7	140
	Fulton	3	60
	Lake	15	300
	Newton	1	20
	Porter	6	120
	White	1	20
11	Jay	2	40
	Miami	3	60
	Wabash	2	40
	Wells	2	40
12	Allen	8	160
	Lagrange	1	20
	Noble	1	20
13	Elkhart	2	26
	Kosciusko	3	60
	Saint Joseph	3	60
Total		220	4,392

INDIAN TERRITORY.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	3	3	80
Total	3	3	80

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Cherokee	1	20
	Choctaw	1	20
	Kiowa	1	40
Total		3	80

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

IOWA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	7	27	593
2	5	9	167
3	4	4	80
4	6	14	303
5	6	13	295
6	6	22	500
7	5	10	220
8	8	39	759
9	6	9	205
10	5	10	214
11	8	15	354
Unaccounted for			1,310
Total	66	172	5,000

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Des Moines	1	20
	Henry	11	235
	Jefferson	7	140
	Lee	2	58
	Louisa	1	20
	Van Buren	2	40
	Washington	3	80
2	Clinton	1	12
	Jackson	2	40
	Jones	3	60
	Muscatine	1	15
	Scott	2	40
3	Black Hawk	1	20
	Butler	1	20
	Delaware	1	20
	Grundy	1	20
4	Alamakee	4	85
	Clayton	6	120
	Fayette	1	20
	Floyd	1	38
	Mitchell	1	20
	Winnesheik	1	20
5	Benton	2	40
	Iowa	2	40
	Johnson	2	50
5—Cont'd	Linn	4	105
	Marshall	2	40
	Tama	1	20
6	Davis	6	140
	Jasper	2	80
	Keokuk	3	60
	Mahaska	2	40
	Poweshiek	3	60
	Wapello	6	120
7	Adair	1	20
	Guthrie	1	20
	Marion	1	40
	Polk	4	80
	Warren	3	60
8	Appanoose	1	20
	Clarke	2	40
	Lucas	5	125
	Page	4	80
	Ringgold	2	40
	Taylor	1	20
	Union	2	50
	Wayne	22	384
9	Cass	3	100
	Crawford	1	11
	Fremont	1	20
	Harrison	1	20
	Montgomery	1	14
	Pottawattamie	2	40
10	Hamilton	2	40
	Kossuth	1	20
	Story	4	80
	Winnebago	1	34
	Wright	2	40
11	Buena Vista	3	60
	Carroll	1	34
	Cherokee	2	60
	Dickinson	2	40
	Palo Alto	1	20
	Plymouth	3	60
	Pocahontas	2	40
	Woodbury	1	40
Total		172	3,690
Number of fish shipped to the State commissioner for distribution unaccounted for			1,310
Grand total		172	5,000

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

KANSAS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	24	99	2,022
2	14	161	3,309
3	19	80	1,681
Not given	13	31	640
Total	70	371	7,652

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Atchison	3	80
	Brown	3	60
	Clay	4	80
	Cloud	2	40
	Dickinson	4	80
	Doniphan	8	160
	Ellis	3	61
	Ellsworth	13	274
	Jefferson	3	60
	Jewell	3	60
	Leavenworth	9	180
	Lincoln	4	80
	Marshall	2	40
	Nemaha	5	120
	Norton	1	20
	Ottawa	2	40
	Phillips	1	20
	Pottawatomie	5	100
	Republic	5	100
	Riley	3	45
	Russell	1	22
	Saline	2	40
	Smith	2	40
	Washington	11	220
2	Allen	9	183
	Anderson	10	200
	Bourbon	17	340
	Cherokee	7	140
2—Cont'd	Crawford	46	920
	Douglass	3	64
	Franklin	14	340
	Johnson	3	60
	Labette	31	620
	Linn	4	80
	Miami	4	100
	Montgomery	6	120
	Neosho	6	122
	Wilson	1	20
3	Barton	2	40
	Butler	4	91
	Chase	1	20
	Chautauqua	1	20
	Coffey	13	260
	Cowley	2	40
	Ford	4	80
	Harvey	3	60
	Lyon	14	280
	McPherson	4	80
	Marion	4	80
	Osage	3	60
	Pawnee	1	20
	Reno	4	80
	Rice	2	40
	Shawnee	6	190
	Sumner	7	140
	Waubaunsee	1	20
	Woodson	4	80
Not given	Barbour	7	149
	Decatur	2	40
	Elk	3	60
	Finney	1	20
	Gove	1	20
	Graham	1	20
	Harper	6	120
	Hodgeman	1	20
	Kingman	2	60
	Morris	1	20
	Ness	1	20
	Thomas	1	20
	Trego	4	80
Total		371	7,652

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

KENTUCKY.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	3	8	160
2	5	12	240
3	6	27	540
4	6	11	220
5	1	52	1,067
6	2	4	85
7	8	28	560
8	6	14	280
9	5	13	276
10	2	6	200
11	4	18	360
Unaccounted for			11,052
Total	48	193	15,040

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Ballard	2	40
	Caldwell	5	100
	Marshall	1	20
2	Christian	1	20
	Daviess	2	40
	Henderson	6	120
	Hopkins	1	20
	Union	2	40
3	Butler	1	20
	Logan	5	100
	Muhlenburg	1	20
	Simpson	1	20
	Todd	2	40
	Warren	17	340
4	Bullitt	3	60
	Hardin	1	20
4—Cont'd	Marion	2	40
	Meade	2	40
	Nelson	2	40
	Washington	1	20
5	Jefferson	52	1,067
6	Kenton	3	65
	Trimble	1	20
7	Bourbon	1	20
	Fayette	5	100
	Franklin	4	80
	Henry	7	140
	Oldham	6	120
	Owen	2	40
	Scott	1	20
	Woodford	2	40
8	Boyle	1	20
	Garrard	1	20
	Lincoln	1	20
	Mercer	1	20
	Shelby	8	160
	Spencer	2	40
9	Fleming	1	20
	Hart	4	80
	Lawrence	2	40
	Lewis	3	76
	Mason	3	60
10	Clark	5	180
	Montgomery	1	20
11	Barren	15	300
	Green	1	20
	Pulaski	1	20
	Taylor	1	20
Total		193	3,988
Number of fish shipped to State commissioner for distribution unaccounted for			11,052
Grand total		193	15,040

LOUISIANA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1 and 2	1	2	28
2	2	2	34
3	2	3	60
4	6	18	346
5	6	16	320
Total	17	41	788

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1 and 2	Orleans	2	28
2	Saint John Baptist	1	14
	Saint Charles	1	20
3	Saint Martin's	1	20
	Saint Mary's	2	40
4	Bienville	2	40
	Bossier	2	40
	Caddo	11	220
	Natchitoches	1	20
	Red River	1	20
	Webster	1	6
5	Claiborne	3	60
	Jackson	1	20
	Ouachita	1	20
	East Baton Rouge	1	20
	East Feliciana	2	40
	Saint Landry	8	160
Total		41	788

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

MAINE.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	8	12	252
Total	8	12	252

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Cumberland	2	52
At large—Continued	Knox	1	20
	Lincoln	2	40
	Penobscot	2	40
	Piscataquis	1	20
	Somerset	1	20
	Waldo	2	40
	York	1	20
Total		12	252

MARYLAND.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	3	7	70
2	2	8	88
2, 3, 4, and 5	1	15	150
5	5	7	100
6	3	26	274
Number of fish unaccounted for			2, 500
Total	14	63	3, 182

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Caroline	2	20
	Kent	2	20
1—Cont'd	Queen Anne	3	30
2	Cecil	6	70
	Harford	2	18
2, 3, 4, and 5	Baltimore	15	150
5	Anne Arundel	2	20
	Calvert	1	20
	Charles	2	30
	Prince George	1	20
	Saint Mary's	1	10
6	Frederick	7	70
	Montgomery	10	104
	Washington	9	100
Total		63	682
Number of fish shipped to State commissioner for distribution unaccounted for			2, 500
Grand total		63	3, 182

MASSACHUSETTS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	1	1	20
4, 5, and 6	1	1	20
5	1	2	30
10 and 11	1	6	120
11	2	4	80
12	2	2	30
Unaccounted for			4, 000
Total	8	16	4, 300

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Barnstable	1	20
4, 5, and 6	Suffolk	1	20
5	Middlesex	2	30
10 and 11	Worcester	6	120
11	Franklin	3	60
	Hampshire	1	20
12	Berkshire	1	10
	Hampden	1	20
Total		16	300
Number of fish shipped to the State commissioner for distribution unaccounted for			4, 000
Grand total			4, 300

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

MICHIGAN.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	1	3	50
2	2	5	50
3	3	4	38
4	5	9	110
5	3	4	40
6	2	2	21
7	1	1	10
8	1	1	20
9	4	5	60
10	4	4	40
Not given	2	3	28
Total	28	41	467

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Wayne	3	50
2	Monroe	1	10
	Washtenaw	4	40
3	Calhoun	1	8
	Eaton	1	10
	Jackson	2	20
4	Berrien	2	21
	Cass	1	10
	Kalamazoo	1	9
	Saint Joseph	2	20
	Van Buren	3	50
5	Allegan	1	10
	Kent	1	10
	Muskegon	2	20
6	Genesee	1	10
	Oakland	1	11
7	Lapeer	1	10
8	Gratiot	1	20
9	Charlevoix	1	20
	Lake	1	10
	Manistee	1	10
	Newaygo	2	20
10	Alpena	1	10
	Clare	1	10
	Ogemaw	1	10
	Oscado	1	10
Not given	Crawford	1	10
	Osceola	2	18
Total		41	467

MINNESOTA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	6	140
2	3	4	80
4	5	6	120
5	7	15	300
Unaccounted for			6,010
Total	19	31	6,650

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Fillmore	3	80
	Houston	1	20
	Steele	1	20
	Winona	1	20
2	Faribault	2	40
2—Cont'd	Lyon	1	20
	Pipestone	1	20
4	Hennepin	1	20
	Kanabec	1	20
	Pine	1	20
	Ramsey	1	20
	Washington	2	40
5	Becker	2	40
	Clay	6	120
	Douglas	1	20
	Morrison	1	20
	Otter Tail	3	60
	Pope	1	20
	Stevens	1	20
Total		31	640
Number of fish shipped to State commissioner for distribution unaccounted for			6,010
Grand total		31	6,650

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

MISSISSIPPI.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	7	15	272
2	8	55	809
4	9	69	955
5	8	28	386
6	4	12	216
7	6	15	240
Total	42	194	2,878

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Alcorn	5	100
	Lee	2	40
	Lowndes	1	12
	Monroe	1	10
	Oktibbeha	2	24
	Prentiss	2	29
	Tishomingo	2	57
2	De Soto	3	60
	Lafayette	19	292
	Marshall	11	181
	Panola	11	136
	Tallahatchee	1	20
2—Cont'd	Tate	6	72
	Tippah	1	12
	Union	3	36
4	Carroll	4	48
	Chickasaw	5	68
	Choctaw	4	80
	Clay	3	36
	Grenada	1	12
	Montgomery	2	24
	Noxubee	3	36
	Winston	17	340
	Yalabusha	11	148
5	Attala	8	110
	Clarke	1	12
	Holmes	2	40
	Leake	2	44
	Newton	5	60
	Smith	1	12
	Wayne	4	48
	Yazoo	5	60
6	Amite	3	60
	Hancock	1	12
	Pike	3	44
	Wilkinson	5	100
7	Claiborne	2	24
	Copiah	1	12
	Hinds	6	108
	Lincoln	1	12
	Madison	3	60
	Rankin	2	24
Total		194	2,878

MISSOURI.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	17	265
2	5	17	300
3	2	7	115
4	1	1	15
5	2	7	105
6	3	19	300
7	3	6	95
8, 9, and 10	1	3	35
10	2	2	35
11	2	2	30
12	4	6	105
13	4	9	135
14	2	2	30
Not given	1	1	15
Total	36	99	1,580

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Knox	5	85
	Lewis	1	15
	Marion	9	135
	Scotland	2	30
2	Carroll	1	20
	Linn	4	65
2—Cont'd	Livingston	1	15
	Monroe	4	60
	Randolph	7	140
3	Clinton	6	100
	Worth	1	15
4	Holt	1	15
5	Johnson	6	90
	Lafayette	1	15
6	Cooper	6	100
	Howard	9	140
	Saline	4	60
7	Audrain	4	60
	Montgomery	1	15
	Saint Charles	1	20
8, 9, and 10	Saint Louis	3	35
10	Iron	1	20
	Madison	1	15
11	Laclede	1	15
	Wright	1	15
12	Barton	1	20
	Bates	1	20
	Cass	1	15
	Saint Clair	3	50
13	Jasper	2	30
	Newton	4	60
	Taney	2	30
	Webster	1	15
14	Dunklin	1	15
	Howell	1	15
Not given	Preston	1	15
Total		99	1,580

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

MONTANA.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	5	7	300
Total	5	7	300

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Deer Lodge	1	50
	Lewis and Clarke	1	50
	Meagher	1	50
	Scott	1	50
	Silver Bow	3	100
Total		7	300

NEBRASKA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	9	355
2	4	9	180
3	6	8	160
Unaccounted for			1,625
Total	14	26	2,320

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Douglas	4	80
	Lancaster	1	20
	Otoe	3	235
	Pawnee	1	20
2	Adams	1	20
	Hitchcock	1	20
	Jefferson	6	120
	York	1	20
3	Antelope	3	60
	Brown	1	20
	Cherry	1	20
	Holt	1	20
	Platt	1	20
	Washington	1	20
Total		26	695
Number of fish shipped to State commissioner for distribution unaccounted for			1,625
Grand total		26	2,320

NEVADA.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	13	46	945
Unaccounted for			1,340
Total	13	46	2,285

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Churchill	1	11
	Elko	6	139
	Esmeralda	3	60
	Eureka	2	40
At large—Continued.	Humboldt	3	60
	Lander	4	80
	Lincoln	1	20
	Lyon	3	60
	Nye	6	120
	Ormsby	7	140
	Storey	1	20
	Washoe	5	100
	White Pine	4	95
Total		46	945
Number of fish sent out for distribution for which no returns have yet been made			1,340
Grand total		46	2,285

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

NEW HAMPSHIRE.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1 and 2	2	6	163
2	3	4	97
Unaccounted for			1,740
Total	5	10	2,000

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1 and 2	Hillsborough	2	55
	Merrimac	4	108
2	Cheshire	2	40
	Grafton	1	20
	Sullivan	1	37
Total		10	260
Number of fish shipped to State commissioner for distribution unaccounted for			1,740
Grand total		10	2,000

NEW JERSEY.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	7	56
2	4	10	151
3	3	9	188
4	4	15	270
5	3	11	183
6	1	9	185
7	1	1	8
Total	20	62	1,041

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Camden	2	16
	Cumberland	1	8
1—Cont'd	Gloucester	2	16
	Salem	2	16
2	Atlantic	4	39
	Burlington	3	55
	Mercer	2	47
	Ocean	1	10
3	Middlesex	1	20
	Monmouth	5	100
	Union	3	68
4	Hunterdon	1	20
	Somerset	3	60
	Sussex	10	180
	Warren	1	10
5	Bergen	4	62
	Morris	3	60
	Passaic	4	61
6	Essex	9	185
7	Hudson	1	8
Total		62	1,041

NEW MEXICO.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	7	12	199
Total	7	12	199

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Bernalillo	1	16
	Colfax	1	20
	Doña Aña	1	15
	Grant	4	82
	Rio Arriba	2	20
	Santa Fé	2	40
	Valencia	1	6
Total		12	199

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

NEW YORK.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	3	16	320
2, 3, and 4	1	5	105
5, 6, 7, 8, 9, 10, and 11	1	7	180
12	1	1	20
13	2	5	95
14	3	24	470
15	2	3	60
16	1	2	40
17	2	2	42
18	1	1	40
20	3	8	200
21	2	4	80
22	2	7	120
23	1	10	170
24	1	2	40
25	1	2	30
26	3	4	75
27	2	3	60
28	2	2	40
29	1	1	20
32	1	4	60
Unaccounted for			2, 023
Total	36	113	4, 290

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Queens	5	100
	Richmond	1	20
	Suffolk	10	200
2, 3, and 4	Kings	5	105
5, 6, 7, 8, 9, 10 and 11.	New York	7	180
12	Westchester	1	20
13	Columbia	2	30
	Dutchess	3	65
14	Orange	10	200
	Rockland	8	160
	Sullivan	6	110
15	Schoharie	1	20
	Ulster	2	40
16	Albany	2	40
17	Rensselaer	1	20
	Washington	1	22
18	Warren	1	40
20	Fulton	2	40
	Montgomery	2	40
	Saratoga	4	120
21	Chenango	1	20
	Otsego	3	60
22	Herkimer	4	70
	Lewis	3	50
23	Oneida	10	170
24	Madison	2	40
25	Onondaga	2	30
26	Cayuga	2	40
	Seneca	1	15
	Wayne	1	20
27	Livingston	2	40
	Ontario	1	20
28	Broome	1	20
	Tompkins	1	20
29	Steuben	1	20
32	Erie	4	60
Total		113	2, 267
Number of fish shipped to State commissioner for distribution unaccounted for			2, 023
Grand total		113	4, 290

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

NORTH CAROLINA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	6	87
2	9	82	1,345
3	8	85	1,383
4	9	218	3,587
5	8	270	4,458
6	9	62	763
7	9	182	2,794
8	13	73	896
Total	69	978	15,313

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Beaufort	1	16
	Hertford	3	35
	Hyde	1	16
	Pasquotank	1	20
2	Edgecombe	13	192
	Greene	12	211
	Halifax	11	199
	Jones	1	20
	Lenoir	5	81
	Northampton	4	64
	Warren	2	40
	Wayne	19	305
	Wilson	15	233
3	Carteret	2	30
	Cumberland	7	124
	Duplin	20	366
	Harnett	14	228
	Moore	15	240
	New Hanover	1	12
	Pender	9	135
	Sampson	17	248
4	Chatham	47	704
	Durham	19	424
	Franklin	14	232
	Granville	5	86
4—Cont'd	Johnston	58	912
	Nash	5	84
	Orange	11	179
	Vance	26	400
	Wake	33	566
5	Alamance	59	1,064
	Caswell	1	10
	Davidson	9	150
	Guilford	133	2,163
	Person	4	80
	Randolph	20	302
	Rockingham	40	629
	Stokes	4	60
6	Anson	3	31
	Cabarrus	2	26
	Catawba	16	235
	Gaston	7	85
	Lincoln	20	186
	Mecklenburg	8	100
	Richmond	1	16
	Robeson	1	16
	Union	4	68
7	Alexander	5	54
	Ashe	1	16
	Davie	4	52
	Forsyth	94	1,445
	Iredell	25	378
	Rowan	14	214
	Surry	15	260
	Wilkes	8	123
	Yadkin	16	252
8	Buncombe	4	42
	Burke	4	43
	Caldwell	3	52
	Clay	4	46
	Cleveland	7	102
	Haywood	1	10
	Henderson	10	116
	McDowell	3	56
	Madison	12	96
	Mitchell	12	140
	Rutherford	6	99
	Transylvania	3	30
	Yancy	4	64
Total		978	15,313

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

OHIO.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1 and 2	2	14	167
3	3	5	63
4	5	7	65
5	2	2	16
6	2	6	57
7	3	22	256
8	3	9	69
9	5	19	184
10	1	1	8
11	4	6	71
12	4	33	359
13	4	18	197
14	3	11	113
15	4	20	231
16	1	9	100
17	5	57	646
18	4	43	498
19	3	11	96
20	3	15	172
Not given	7	20	196
Unaccounted for			1,436
Total	68	328	4,000

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1 and 2	Hamilton	12	117
	Ross	2	50
3	Miami	2	28
	Montgomery	1	20
	Preble	2	15
4	Allen	1	20
	Auglaize	2	16
	Darke	1	10
	Mercer	1	7
	Shelby	2	12
5	Seneca	1	10
	Wyandot	1	6
6	Defiance	5	45
	Williams	1	12
7	Butler	4	55
	Clermont	6	71
	Warren	12	130
8	Clarke	3	21
	Logan	6	48
9	Delaware	1	20
	Hardin	2	28
	Knox	10	80
9—Cont'd	Morrow	2	16
	Union	4	40
10	Ottawa	1	8
11	Gallia	2	16
	Hocking	2	40
	Scioto	1	6
	Vinton	1	9
12	Coshocton	4	82
	Licking	15	115
	Muskingum	6	84
	Tuscarawas	8	78
13	Fairfield	3	24
	Franklin	7	70
	Perry	3	26
	Huron	5	77
14	Ashland	7	87
	Lorain	1	8
	Richland	3	18
15	Athens	11	152
	Meigs	2	18
	Morgan	1	8
	Washington	6	53
16	Holmes	9	100
17	Belmont	28	351
	Guernsey	14	173
	Harrison	9	74
	Jefferson	3	24
	Noble	3	24
18	Carroll	3	60
	Columbiana	18	158
	Mahoning	6	47
	Stark	16	233
19	Ashtabula	2	18
	Portage	2	16
	Trumbull	7	62
20	Cuyahoga	6	74
	Medina	3	38
	Summit	6	60
Not given	Adams	1	9
	Brown	2	16
	Clinton	3	36
	Fayette	1	8
	Highland	5	52
	Pike	1	20
	Wayne	7	55
Total		328	3,564
Number of fish sent out for distribution for which no returns have yet been made			1,436
Grand total		328	4,000

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

OREGON.

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Benton	3	65
	Clackamas	11	470
	Clatsop	1	50
	Douglas	2	100
	Tillamook	1	50
	Jackson	2	70
	Klickitat	1	50
	Lake	2	....
	Lane	1	50
	Linn	4	175
At large—C'd	Marion	17	855
	Multnomah	28	1,310
	Polk	4	145
	Umatilla	1	20
	Union	1	...
	Wasco	1	50
	Washington	10	310
	Yam Hill	17	495
Total		107	4,265

PENNSYLVANIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	1	10	134
1, 2, 3, 4, and 5	1	8	80
6	2	45	541
7 and 10	1	8	123
8	1	71	870
9	1	10	101
10	2	18	203
11	3	4	48
12	1	7	55
13	1	14	169
14	2	7	93
15	3	7	145
16	1	1	7
17	6	19	299
18	5	16	321
19	2	23	258
20	4	9	96
21	3	26	372
23	1	3	71
24	3	39	339
25	5	22	267
26	3	13	156
27	2	4	35
Number of fish unaccounted for	....	....	1,000
Total	54	384	5,783

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Montgomery	10	134
1, 2, 3, 4, and 5	Philadelphia	8	80
6	Chester	43	501
	Delaware	2	40
7 and 10	Bucks	8	123
8	Berks	71	870
9	Lancaster	10	101
10	Lehigh	16	187
	Northampton	2	16
11	Columbia	1	20
	Monroe	2	20
	Pike	1	8
12	Lackawanna	7	55
13	Schuylkill	14	169
14	Dauphin	3	48
	Lebanon	4	45
15	Bradford	4	108
	Susquehanna	2	17
	Wayne	1	20
16	Lycoming	1	7
17	Bedford	3	74
	Blair	2	40
	Cambria	3	42
	McKean	2	28
	Somerset	5	88
	Tioga	4	27
18	Franklin	2	20
	Fulton	2	40
	Huntingdon	10	201
	Juniata	1	20
	Snyder	1	40
19	Adams	5	69
	York	18	189
20	Centre	1	8
	Clearfield	2	16
	Mifflin	1	20
	Union	5	52
21	Greene	5	41
	Fayette	5	39
	Westmoreland	16	292
23	Allegheny	3	71
24	Beaver	3	34
	Lawrence	5	40
	Washington	31	265
25	Armstrong	7	82
	Clarion	5	66
	Forest	2	18
	Indiana	5	65
	Jefferson	3	36
26	Butler	3	46
	Crawford	5	54
	Mercer	5	56
27	Erie	1	8
	Venango	3	27
Total		384	4,783
Number of fish shipped to State Commissioner for distribution unaccounted for		......	1,000
Grand total		384	5,783

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

RHODE ISLAND.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
2	1	2	32
Total	1	2	32

Congressional district.	County.	No. of applicants.	No. of fish.
2	Providence	2	32
Total		2	32

SOUTH CAROLINA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	2	108	2,160
2	5	147	2,940
3	5	253	5,060
4	5	162	3,362
4 and 5	1	4	80
5	4	16	320
6	5	17	345
7	4	40	782
Not given	1	17	340
Total	32	764	15,389

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Charleston	3	60
	Lexington	105	2,100
2	Aiken	10	200
	Barnwell	27	540
	Colleton	3	60
	Edgefield	104	2,080
2—Cont'd	Hampton	3	60
3	Abbeville	23	460
	Anderson	100	2,000
	Newberry	17	340
	Oconee	86	1,720
	Pickens	27	540
4	Fairfield	6	122
	Greenville	24	580
	Laurens	40	800
	Richland	16	320
	Spartanburg	76	1,540
4 and 5	Union	4	80
5	Chester	5	100
	Chesterfield	1	20
	Kershaw	5	100
	Lancaster	5	100
6	Clarendon	2	40
	Darlington	10	205
	Marion	2	40
	Marlborough	2	40
	Williamsburg	1	20
7	Beaufort	1	20
	Berkeley	6	102
	Orangeburg	28	560
	Sumter	5	100
Not given	York	17	340
Total		764	15,389

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

TENNESSEE.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	9	86	970
2	6	27	507
3	7	25	233
4	6	24	239
5	5	8	117
6	5	13	212
7	3	17	267
8	3	11	180
9	7	26	415
10	3	38	676
11	1	4	64
Not given	2	5	79
Total	57	284	3,959

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Carter	4	34
	Claiborne	4	42
	Cocke	4	42
	Greene	14	104
	Hamblen	2	25
	Hawkins	5	44
	Sullivan	2	28
	Unicoi	5	49
	Washington	40	602
2	Anderson	2	8
	Blount	11	128
	Jefferson	5	44
	Knox	4	47
	Loudon	3	260
	Sevier	2	20
3	Bradley	8	76
	Cumberland	2	13
3—Cont'd	Hamilton	1	8
	James	2	12
	McMinn	2	20
	Marion	3	44
	White	7	60
4	Fentress	1	8
	Robertson	2	24
	Smith	3	19
	Sumner	2	30
	Trousdale	6	39
	Wilson	10	119
5	Bedford	1	20
	Coffee	1	15
	Lincoln	3	37
	Marshall	2	30
	Rutherford	1	15
6	Chatham	1	12
	Davidson	7	115
	Houston	1	15
	Humphrey	1	15
	Montgomery	3	55
7	Giles	7	110
	Maury	4	70
	Williamson	6	87
8	Carroll	3	50
	Hardin	1	15
	Madison	7	115
9	Crockett	2	26
	Dyer	3	60
	Gibson	1	20
	Haywood	7	99
	Lauderdale	3	55
	Tipton	1	20
	Weakley	9	135
10	Fayette	17	274
	Hardeman	1	15
	Shelby	20	387
11	Henry	4	64
Not given	Dauphin	1	6
	Henderson	4	73
Total		284	3,959

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

TEXAS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	8	15	191
2	5	50	753
3	6	29	370
4	6	52	778
5	10	154	1,839
6	7	45	535
7	4	6	106
8	5	20	238
9	7	28	389
10	3	16	268
11	12	20	323
Total	73	435	5,790

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Angelina	1	5
	Brazos	3	44
	Grimes	4	66
	Harris	3	44
	Montgomery	1	10
	San Jacinto	1	2
	Trinity	1	8
	Waller	1	12
2	Anderson	39	554
	Cherokee	7	140
	Freestone	2	19
	Robertson	1	20
	Sabine	1	20
3	Hunt	1	20
	Panola	1	20
	Rusk	10	121
	Shelby	15	169
	Van Zandt	1	20
	Wood	1	20
4	Bowie	1	20
	Cass	2	24
	Hopkins	24	313
	Lamar	7	104
	Marion	15	292
	Titus	3	25
5	Archer	2	40
	Clay	7	82
	Collin	29	483
	Cook	2	20
	Denton	6	59
	Grayson	99	1,003
	Matagorda	3	60
	Montague	4	70
	Wichita	1	13
	Wise	1	9
6	Dallas	9	132
	Ellis	7	74
	Galveston	1	12
	Hill	1	20
	Johnson	4	56
	Coffman	20	221
	Tarrant	3	20
7	DeWitt	2	40
	Duval	1	20
	Fort Bend	1	20
	Nueces	2	26
8	Colorado	2	24
	Fayette	13	139
	Hays	3	35
	Karnes	1	20
	Live Oak	1	20
9	Bell	2	24
	Burleson	1	12
	Limestone	5	45
	McLennan	5	50
	Milan	1	7
	Navarro	13	239
	Washington	1	12
10	Bastrop	2	25
	Travis	3	52
	Williamson	11	191
11	Brown	2	30
	Comanche	1	13
	Donley	1	20
	Eastland	4	25
	El Paso	3	42
	Howard	1	100
	Parker	1	12
	Palo Pinto	1	8
	Somervell	1	10
	Stephens	3	31
	Wheeler	1	20
	Young	1	12
Total		435	5,790

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

UTAH.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	17	93	1,833
Unaccounted for			300
Total	17	93	2,133

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Beaver	2	40
	Box Elder	6	123
	Cache	4	80
	Garfield	2	40
	Iron	2	40
	Juab	2	40
At large—C'd.	Kane	6	120
	Millard	25	500
	Morgan	1	20
	Salt Lake	15	260
	San Pete	1	20
	Sevier	1	20
	Tooele	4	80
	Summit	6	130
	Utah	6	120
	Washington	3	60
	Weber	7	140
Total		93	1,833
Number of fish sent out for distribution for which no returns have yet been made			300
Grand total		93	2,133

VERMONT.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	4	13	260
2	6	19	381
Unaccounted for			800
Total	10	32	1,441

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Addison	1	20
	Bennington	3	60
	Franklin	3	60
	Rutland	6	120
2	Caledonia	3	60
	Orange	1	20
	Orleans	6	121
	Washington	3	60
	Windham	4	80
	Windsor	2	40
Total		32	641
Number of fish shipped to State Commissioner for distribution unaccounted for			800
Grand total		32	1,441

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

VIRGINIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	9	23	228
2	7	22	309
3	6	29	293
4	11	60	850
5	5	32	410
6	8	49	821
7	8	109	1,417
8	11	131	1,398
9	8	37	496
Total	73	492	6,222

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Accomac	4	32
	King and Queen	3	26
	King George	3	35
	King William	3	23
	Middlesex	2	33
	Prince William	4	32
	Spottsylvania	1	10
	Stafford	1	7
	Westmoreland	2	30
2	Nansemond	2	40
	New Kent	1	10
	Norfolk	4	35
	Southampton	9	136
	Sussex	3	56
	Warwick	1	7
	York	2	25
3	Caroline	1	8
	Chesterfield	1	20
	Hanover	9	73
	Henrico	10	113
	Louisa	7	69
	Richmodn	1	10
4	Amelia	8	76
	Brunswick	5	103
	Charlotte	8	84
	Cumberland	8	160
	Dinwiddie	4	70
4—Cont'd	Greenville	1	8
	Lunenburg	9	73
	Mecklenburg	1	10
	Nottoway	3	51
	Powhatan	4	35
	Prince Edward	9	180
5	Floyd	1	20
	Franklin	3	60
	Halifax	8	86
	Henry	1	20
	Pittsylvania	19	224
6	Amherst	1	10
	Appomattox	2	30
	Bedford	11	164
	Botetourt	5	80
	Buckingham	3	50
	Campbell	19	346
	Nelson	3	49
	Rockbridge	5	92
7	Albemarle	27	307
	Augusta	23	258
	Fluvanna	3	40
	Green	3	23
	Highland	1	10
	Page	4	33
	Rockingham	48	616
	Shenandoah	15	130
8	Alexandria	3	60
	Clark	1	12
	Culpeper	5	44
	Fairfax	6	63
	Fauquier	38	384
	Frederick	6	51
	Loudoun	6	71
	Madison	9	127
	Orange	32	334
	Rappahannock	23	232
	Warren	2	20
9	Craig	1	20
	Montgomery	3	60
	Roanoke	5	65
	Russell	1	10
	Smythe	1	10
	Tazewell	1	10
	Washington	17	205
	Wythe	8	116
Total		492	6,222

WASHINGTON.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	11	46	1,616
Total	11	47	1,616

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Clark	4	170
	Cowlitz	3	150
	Columbia	2	70
	Garfield	1	20
	Pierce	1	50
	San Juan	1	20
	Snohomish	1	20
	Spokan	6	210
	Thurston	5	185
	Walla Walla	21	685
	Whatcom	2	36
Total		47	1,616

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1883—Continued.

WEST VIRGINIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	3	9	83
2	10	52	670
3	5	5	54
4	1	1	8
Total	19	67	815

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Harrison	6	59
	Marshall	1	7
1—Cont'd	Ohio	2	17
2	Berkeley	3	36
	Hampshire	2	28
	Hardy	3	23
	Jefferson	23	395
	Marion	5	54
	Mineral	1	8
	Monongahela	1	8
	Morgan	2	17
	Preston	11	93
	Taylor	1	8
3	Greenbrier	1	10
	Kanawha	1	8
	Mercer	1	8
	Monroe	1	20
	Summers	1	8
4	Roane	1	8
Total		67	815

WISCONSIN.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
1	2	3	150
2	3	5	220
3	2	4	140
4	1	3	150
5	2	2	100
6	1	2	100
7	3	4	110
8	2	2	70
Not given	1	1	20
Total	17	26	1,060

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Rock	1	100
	Walworth	2	50
2	Fon Du Lac	2	70
	Washington	2	100
	Waukesha	1	50
3	Green	3	90
	Lafayette	1	50
4	Milwaukee	3	150
5	Calumet	1	50
	Sheboygan	1	50
6	Winnebago	2	100
7	Monroe	1	50
	Sauk	2	40
	Vernon	1	20
8	Jackson	1	20
	Trempealeau	1	50
Not given	Dane	1	20
Total		26	1,060

WYOMING.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.
At large	5	27	560
Total	5	27	560

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Albany	2	60
	Carbon	9	180
	Johnson	1	20
	Laramie	13	260
	Uintah	2	40
Total		27	560

DISTRIBUTION OF CARP IN CANADA IN 1883.

CANADA.

Province.	No. of applicants.	No. of fish.
Ontario	1	100
Total	1	100

As incidental to the distribution of carp, and in conjunction with it, a moderate number of the gold orfe and fancy gold fish have been sent to applicants in the various States and Territories of the United States. A summary of the number distributed in 1882 and 1883 will be found in Tables III and IV.

TABLE III.—*DISTRIBUTION OF GOLD FISH DURING THE YEARS* 1883–'84.

State.	Number of applicants.	Number of fish.	State.	Number of applicants.	Number of fish.
Alabama	1	6	Missouri	1	6
Arizona Territory [1]	2	36	Mississippi	1	6
California	1	12	Nebraska	5	15
Connecticut	1	20	New Hampshire	1	3
Delaware [2]	4	116	New Jersey	8	39
District of Columbia [3]	317	2, 058	New York	5	30
Florida	1	4	North Carolina	18	76
Georgia [4]	47	271	Ohio	15	89
Illinois	5	34	Pennsylvania	5	32
Indiana	203	862	Rhode Island	2	14
Indian Territory	1	6	Tennessee	3	21
Iowa	2	12	Texas [6]	7	315
Kansas	3	41	Utah Territory	5	12
Kentucky	17	58	Virginia [7]	59	510
Maryland [5]	16	95	West Virginia	4	19
Massachusetts	16	46	Wyoming Territory	7	14
Michigan	19	123			
			Total	802	5, 001

[1] Thirty-six delivered to State Commissioner John J. Gosper for distribution.
[2] One hundred delivered to Commissioner Enoch Moore, jr., for distribution.
[3] One hundred and sixty delivered to George H. H. Moore for distribution to Baltimore and Potomac Railroad employés. Two hundred delivered to Col. A. F. Rockwell for public fountains. Twenty-five delivered to C. A. Stewart for fountain in National Museum. Twelve delivered to Mrs. T. L. Frecker for exhibit at Garfield Memorial Fair.
[4] Twelve expressed to Messenger G. G. Davenport at Atlanta for distribution. Seventy-five expressed to Messenger F. L. Donnelly at Atlanta for distribution. Fifty delivered to Commissioner J. T. Henderson, Atlanta, for distribution.
[5] Twenty delivered to J. F. Legge for public fountains in Cumberland.
[6] Two hundred delivered to Commissioner R. R. Robertson, Austin, Tex., for distribution. Fifty delivered to Commissioner John B. Lubbock, Austin, Tex., for distribution.
[7] Twenty delivered to W. H. Dulaney for public fountains in Lynchburg, Va. Three hundred and fifty expressed to George A. Seagle, Wytheville, Va., for distribution.

TABLE IV.—*DISTRIBUTION OF GOLD ORFE DURING THE YEARS* 1882–'84.

Name.	Post-office address.	Number of fish.
Col. A. F. Rockwell	Washington, D. C	6
J. H. Rathbone	Washington, D. C	2
W. Williams	Washington, D. C	2
Henry P. Farrow	Atlanta, Ga	12
Dr. H. H. Cary	La Grange, Ga	12
Hon. J. Fred. C. Talbott	Lutherville, Md	6
Martin Metcalf	Battle Creek, Mich	6
J. G. W. Steedman	Saint Louis, Mo	12
B. E. B. Kennedy	Omaha, Nebr	30
E. D. Sturtevant	Bordentown, N. J	4
E. G. Blackford	New York City	4
Kemp Gaines	Springfield, Ohio	5
B. V. Moore	Rix's Mills, Ohio	4
W. H. Aiken	New Castle, Pa	4
M. S. Carty	San Antonio, Tex	4
Nat. Mitchell	do	4
Total		117

Car No. 2, having completed the distribution of carp to the States traversed by the Union Pacific Railroad, reported at headquarters in Washington December 10, and having been overhauled and the necessary repairs completed, was dispatched to Northville, Mich., to report to F. N. Clark, superintendent of the Northville Station, for service in making the whitefish distribution.

It was engaged continuously in this work from February 21, when the first shipment of 3,000,000 fry was made to Lake Michigan, to April 8, when the work closed with a shipment of 1,000,000 whitefish fry to Lake Erie. A subsequent trip was made April 11, with 75,000 salmon trout, which were deposited as follows:

In Crooked Lake, Michigan	20,000
In Cranberry Lake, Michigan	20,000
In Star Lake, Michigan	35,000

On the same trip 10,000 fry of the European trout, *Salmo fario*, were transported to and planted in the headwaters of the Pere Marquette River. The ova from which these fry were hatched were donated by the Deutsche Fischerei-Verein. The results of the experiment will be looked for with a great deal of interest, as it is believed that the European trout will be found to do well in many streams in which our common brook trout do not thrive.

A statement of the whitefish distribution, so far as accomplished by car and messenger service, will be found in Table V. A summary of the entire distribution of ova and frey from the Northville and Alpena Stations will be found in the report of F. N. Clark, superintendent of these stations.

TABLE V.—*STATEMENT OF WHITEFISH FRY PLANTED IN WATERS OF THE UNITED STATES DURING THE SEASON OF 1883-'84.*

Date.	Waters stocked.	Place of deposit.	Number of fish.
1884.			
Feb. 21	Lake Michigan	Manistee, Mich	3,000,000
23	......do	Grand Haven, Mich	3,000,000
23	Potomac River	West Virginia Junction, W. Va	500,000
26	......do	Near Keyser, W. Va	500,000
27	Lake Erie	Erie, Pa	3,000,000
Mar. 5	Lake Michigan	Traverse City, Mich	3,000,000
11	Lake Ontario	Oswego, N. Y	3,000,000
14	Lake Huron	Port Huron, Mich	3,000,000
17	Lake Ontario	Oswego, N. Y	3,000,000
21	Lake Michigan	Ludington, Mich	3,000,000
22	Lake Huron	Fort Gratiot, Mich	3,000,000
25	Lake Erie	Monroe, N. Y	3,000,000
26	......do	North Bass Island, Ohio	1,500,000
26	......do	Put-in-Bay Island, Ohio	1,500,000
Apr. 1	Lake Michigan	Racine, Wis	1,000,000
1	......do	Milwaukee, Wis	2,000,000
1	......do	Sheboygan, Wis	1,000,000
8	Lake Erie	Put-in-Bay Island, Ohio	1,000,000
8	......do	North Bass Island, Ohio	1,000,000
24	Lake Superior	Ashland, Wis	4,000,000
May 6	Lake Michigan	Escanaba, Mich	4,000,000
Apr. 8	Lake Erie	Ottawa City, Ohio	1,000,000
		Total	49,000,000

Of the above, the 1,000,000 planted in tributaries of the Potomac River were hatched at Central Station and planted under the direction of Mr. J. E. Brown; all the rest were obtained from Northville and taken to destination by J. F. Ellis, messenger in charge.

One million whitefish eggs were sent to Alfred Greenfield for Acclimatization Society, New Zealand, by F. N. Clark, from Northville, Mich., January 5, 1884, and were received in good condition.

Car No. 1, in charge of George H. H. Moore, did not complete the distribution of carp to Louisiana, Texas, Arizona, and New Mexico and report at headquarters until January 10, 1884. Mr. Carswell, messenger attached to the car, was immediately sent to the trout-breeding station at Wytheville, Va., to assist in the work at the hatchery; and as soon as the necessary repairs were completed, the car was ordered to Wytheville to distribute the different *Salmonidæ* that had been bred at the station during the seasons of 1882 and 1883. A summary of the distribution of *Salmonidæ* for the season of 1883, from Wytheville, Va., Northville, Mich., and Central Station, Washington, D. C., will be found in Table VI.

TABLE VI.—*SUMMARY OF DISTRIBUTION OF SALMONIDÆ FOR* 1883.

Date.	Station furnishing the fish.	Variety of fish. California trout. One year old.	California trout. Two years old.	California trout. Three years old.	Brook trout. Fry.	Brook trout. One year old.	Salmon trout, fry.	Rangely trout, one year old.	German trout (*S. fario*), fry.	Maine salmon, fry.	Water stocked.	Point of deposit.
Apr. 16	Wytheville		50								Private pond, Hon. C. Delano	Mount Vernon, Ohio.
10	do	100									Morgan's Run	Clarke County, Virginia.
10	do		100								do	Do.
10	do					50					do	Do.
10	do							50			do	Do.
10	do									50,000	Oswego River	Near Fulton, N. Y.
10	do	350									Harris Run	3½ miles from Oswego, N. Y.
10	do		100								do	Do.
18	Central						80,000				Potomac River	Cumberland, Md.
17	do						500				Stony Creek	Lutherville, Md.
11	Northville						20,000				Crooked Lake	Michigan.
11	do						20,000				Cranberry Lake	Do.
14	do						35,000				Star Lake	Do.
14	do								10,000		Pere Marquette River	Near Baldwin, Mich.
Mar. 19	Wytheville		350								Wautauga River	Carters, Tenn.
19	do		324								Hiawassie River	Calhoun, Tenn.
19	do		100								Private pond, Tipton Jobe	Johnson City, Tenn.
19	do		368								Will's Creek	De Kalb County, Alabama, railroad crossing.
19	do		387								Warrior River	Warrior's Station, Ala.
19	do		396								Cahawba River	Shelby County, Alabama, railroad crossing.
19	do		400								Chockelecko River	Oxford, Ala.
19	do		370								Tallapoosa River	Railroad crossing, Alabama.
19	do		400								Etowah River	Carterville, Ga.
19	do		398								Coosawattie River	Railroad crossing, Georgia.
5	do		150		5,000						Mill Creek	Near Round Knob, N. C.
Feb. 25	do				4,500						Spring Creek	Near Warm Spring, N. C.
25	do				5,500						Laurel River	Do
Apr. 10	do	30	6	6				6			E. G. Blackford, New York commissioner, for exhibition.	
	Total	480	3,839	6	15,000	50	105,500	56	10,000	50,000		

NOTE.—The ova of the *Salmo fario* were donated by the Deutsche Fischerei-Verein.

The distribution of California trout, two years old, marks a new departure in the work of the Fish Commission, and one which promises most important results. The rainbow trout (*Salmo iridea*) sent out were from 5 to 7 inches long, and in weight ranged from 5 to 8 ounces. Being protected by their size from the attacks of the predaceous fishes occupying the waters in which they were placed, it is believed that the plants of four hundred fish, made in a number of the South Atlantic and Gulf streams will be more effective in colonizing those waters than plants of 50,000 fry made before the absorption of the sack has been completed, when they are alike helpless to resist attack and have not the vigor or activity to escape danger by running away from it.

As heretofore, the railroads have been liberal in granting free transportation for our cars. This is especially true of the great trunk lines beyond the Mississippi, and we have thus been enabled to extend the benefits of the work of the Commission to remote sections of the country, which otherwise would have been inaccessible by reason of the cost of transportation.

Statement of free transportation furnished the United States Fish Commission in 1883.

TO CAR No. 1 AND MESSENGERS.

Name of company.	From—	To—	Distance.
			Miles.
Saint Louis, Iron Mountain and Southern.	Saint Louis, Mo	Texarkana, Ark., and return	980
Texas and Pacific	Texarkana, Ark	El Paso, Tex., and return	1,738
Burlington and Missouri	Omaha, Nebr	South Bend, Nebr., and return	46
Richmond and Alleghany	Richmond, Va	Lorraine, Va., and return	24
Northern Pacific	Saint Paul, Minn	Wallula Junction, Wash., and return.	3,396
Oregon Railway and Navigation Company.	Wallula Junction, Wash	Portland, Oreg., and return	428
Do	do	Walla Walla and return	96
Texas and Pacific	New Orleans, La	Marshall, Tex	368
Missouri Pacific	Tyler, Tex	Dallas, Tex	104
International and Great Northern	Palestine, Tex	Austin, Tex., thence to Tyler	412
Atchison, Topeka and Santa Fé	Albuquerque, N. Mex	Kansas City, Mo	918
Total			8,510

TO CAR No. 2 AND MESSENGERS.

Saint Louis and Iron Mountain	Saint Louis, Mo	Texarkana, Ark	490
Do	Texarkana, Ark	Saint Louis, Mo	490
Texas Pacific	do	Fort Worth, Tex	244
Do	Fort Worth, Tex	Dallas, Tex	32
Do	Dallas, Tex	Fort Worth, Tex., and return	64
Do	Long view, Tex	Texarkana, Ark	97
Houston and Texas Central	Dallas, Tex	Hearne, Tex	144
International and Great Northern	Hearne, Tex	Austin, Tex	91
Do	Austin, Tex	Laredo, Tex	234
Do	Laredo, Tex	Long View, Tex	496
Flint and Pere Marquette	Toledo, Ohio	Northville, Mich., and return	124
Do	do	Northville, Mich	62
Do	Northville, Mich	Detroit, Mich., and return (3 trips).	180
Do	do	Toledo, Ohio, and return, (2 trips).	248
Do	do	Detroit, Mich	30
Do	Detroit, Mich	Northville, Mich., and return	60
Do	do	Bay City, Mich	121
Do	Bay City, Mich	Holly, Mich., and return	128
Do	do	Ludington, Mich., and return	298
Do	do	Reed City, Mich., and return	196
Do	do	Flint, Mich	46
Lake Shore and Michigan Central	Toledo, Ohio	Cleveland, Ohio, and return	226

Statement of free transportation furnished United States Fish Commission in 1883—Cont'd.

TO CAR NO. 2 AND MESSENGERS—Continued.

Name of company.	From—	To—	Distance.
			Miles.
Michigan Central	Grand Trunk Junction, Mich.	Detroit, Mich., and return	20
Great Western of Canada	Detroit, Mich	Niagara, Ontario, and return (3 trips).	1,380
Rome, Watertown and Ogdensburg	Charlotte, N. Y	Oswego, N. Y. (2 trips)	280
Do	Around Oswego (2 trips)		24
Detroit, Grand Haven and Milwaukee.	Holly, Mich	Grand Haven, Mich., and return.	248
Do	Around Detroit, Mich. (3 trips).		19
Grand Rapids and Indiana	Reed City, Mich	Harbor Springs and return	260
Chicago and Grand Trunk	Flint, Mich	Chicago, Ill	269
Do	Around Chicago		16
Marquette, Houghton and Ontonagon.	Negaunee, Mich	Marquette, Mich	12
Do	Marquette, Mich	Michigamee, Mich	126
Do	do	L'Anse, Mich	26
Do	Michigamee, Mich	Negaunee, Mich., and return	300
Detroit, Mackinac and Marquette	Marquette, Mich	Saint Ignace, Mich., and return (3 times).	900
Utah Central	Ogden, Utah	Salt Lake City, Utah, and return.	74
Total			8,429

TO DETACHED MESSENGERS.

Name of company.	From—	To—	Distance.
Oregon Railway and Navigation Company.	San Francisco, Cal	Portland, Oreg., and return	*1,200
Utah Central Railroad	Ogden, Utah	Salt Lake, Utah, and return	74
Atlantic and Pacific	Albuquerque, N. Mex	Laguna, N. Mex., and return	132
Atchison, Topeka and Santa Fé	Kansas City, Mo	Albuquerque, N. Mex., and return.	694
Texas Pacific	Texarkana	Paris, Tex	91
Do	do	Shreveport, La	114
Do	Shreveport, La	Longview, Tex	63
Do	Mineola, Tex	Dallas, Tex	78
Houston and Texas Central	Dallas, Tex	Corsicana, Tex., and return	108
International and Great Northern	Palestine, Tex	Mineola, Tex	90
Do	Longview, Tex	Palestine, Tex	81
Total			2,725

* Estimated.

XXXIII.—REPORT OF OPERATIONS IN HATCHING EGGS OF SPANISH MACKEREL IN CHESAPEAKE BAY BY STEAMER FISH HAWK DURING THE SUMMER OF 1883.

By Lieut. W. M. WOOD, U. S. N., Commanding.

I have the honor to submit the following report on the operations of this vessel in the Chesapeake Bay during the past summer.

We left Washington on June the 4th, and located and made a list of the trap-nets fished on the Potomac River, west side of bay from Potomac River down, and east side up as far as Cherrystone Inlet. As I have already submitted a detailed report of this portion of the work, I will only mention that I finished it on June the 12th, and then gave my attention to the propagation of the Spanish mackerel.

The first mackerel I heard of being caught were taken at the mouth of the Rappahannock River June 5, and were only two in number. From the 5th to the 21st but few mackerel were taken anywhere, and of these most were caught on the west side of bay.

On the 21st we got our first spawn, one ripe female being found in the catch of the nets off Butler Bluffs in the morning and another in Mobjack Bay in the afternoon. By this time most of the fishermen on the west shore had taken up their nets and quit, there being only one in Mobjack Bay and three or four on York Spit.

On the eastern shore, however, they were in many instances putting down new nets or altering and overhauling the old ones. They told me that by the law they were not allowed to fish trap nets until the 25th of June, and to evade this the few nets in operation before that date were provided with funnel openings to the trap and called "fykes."

The eastern-shore fishermen also state that their catch of mackerel does not begin usually until the end of June (several weeks later than on the western shore), but is much larger and lasts longer when it does begin, the catch running well into September. They, however, catch but few shad there. Owing to the early catch and short duration of the season on the west side of bay it is quite evident that all future operations, if there are any, should be on the eastern shore. The mouth

of Cherrystone Inlet, or at Plantation Creek, where there is soon to be a railroad terminus, are probably the most convenient localities.

The fishermen only lift their nets once a day, at slack high water, if possible, but varying to suit the arrival of their "run boats," which carry all the fish to Norfolk. On Sundays they do not fish at all, nor can they fish, except at or near slack water, high or low, on account of the strong tidal current. Their nets are all hung on small galvanized wire rope on account of this current.

The catch during July, though on no occasion very large, was good, running up on some occasions to 2,000 to 3,000 mackerel to a set of nets; but notwithstanding this our spawn-takers were able to find but very few ripe fish, one or two only in a pocket, the majority being "spent fish."

I can only account for this by supposing that all the fish near spawning time deposit their eggs from fright after they are trapped. When you remember that these nets are fished but once in twenty-four hours (in rough weather and over Sunday but once in forty-eight hours or more), and that during that time they are penned in a very small space with hundreds of other fish, including sharks, dogfish, ray, gar, bluefish, &c., as well as numberless crabs, it is not surprising premature spawning is the result; and the chances are that, for the same reasons, the eggs are unfertilized by the males. If this be so, a partial remedy would seem to lie in fishing the nets frequently, say on every slack water, or four times in twenty-four hours. The fishermen would scarcely do this without compensation, however. We had but poor results from the eggs we did get, and I am convinced that, unless this was an abnormal season, none of the apparatus so far invented, unless possibly a modification of the last, will answer.

From what I had been able to learn before leaving Washington, from Colonel McDonald and the officers of this vessel, of the previous work done in this direction, I determined to use glass as far as possible, and the first experiments were made with an apparatus suggested by Mr. Smith and Dr. Kite. It consisted of a glass jar with an open induction pipe and strainer-covered waste-pipe, the lower end of which was placed well below the surface. The results were not good; a fair percentage of the fish hatched, but commenced to die immediately. This was ascribed to all sorts of causes. The material of which the strainers were made was changed from mica to tin, tin to bolting silk, and silk to Swiss muslin, but without any change. I finally concluded the mischief must come from the fountain head and lie either in the action of the salt-water on the metal of our circulating pump or iron tanks. To test this I had a number of fine looking eggs placed in a large glass jar, from which I had the water siphoned every half hour and replaced by sea-water drawn by hand in a clean bucket. The result was precisely the same. The eggs hatched just as well as they had previously done and the young fish died just as rapidly.

I then arranged the apparatus, of which I submit a sketch, Fig. 1. It was made entirely of cedar wood and glass, but as I was only able to get eggs for it once I can scarcely tell what might have been done with

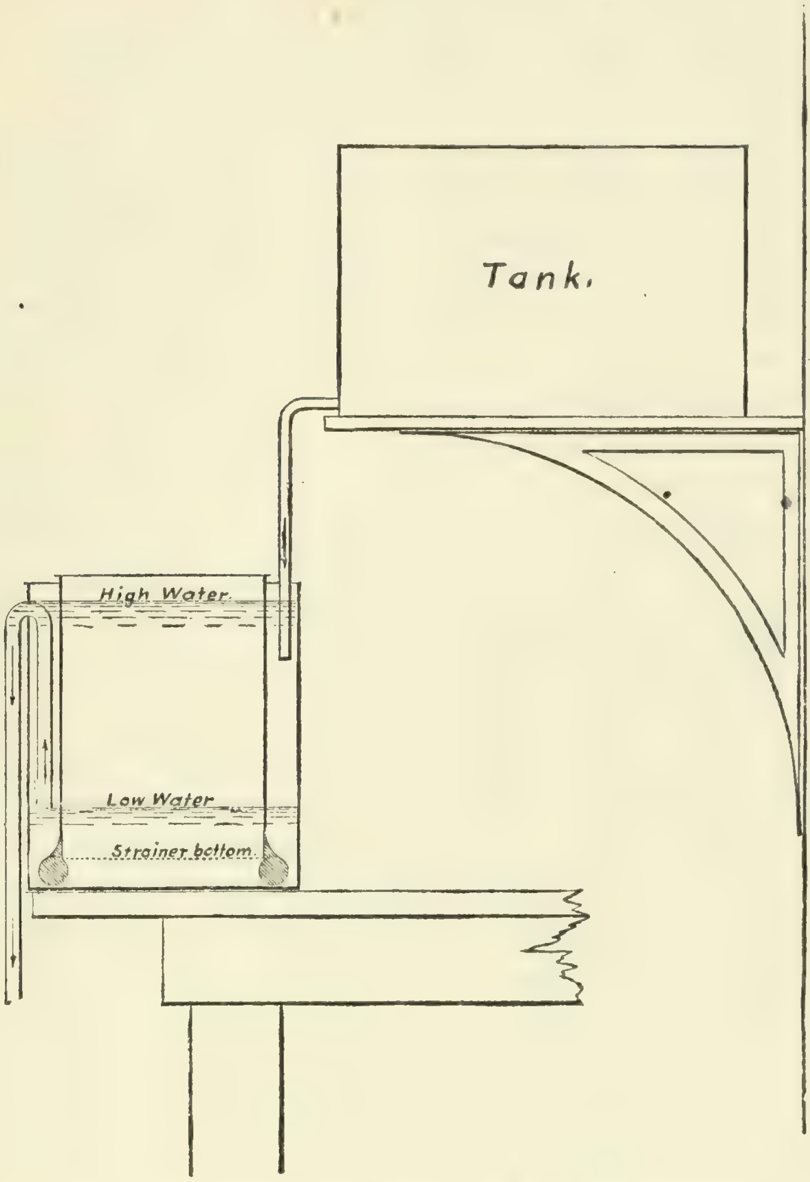


FIG. 1.—Apparatus for hatching Spanish mackerel.

it. The one time it was tried the result was no better than in the former cases.

Previously we had tried McDonald jars, and a porcelain apparatus which I found stored at the armory, consisting of an outer jar with an inner one having perforated sides and bottom. The result was much alike in all.

I noticed that many of the young fish hatched were curved as though they had never straightened out after breaking from the egg.

Comparing what we did this year with the results of last year, I think it will be extremely difficult, if not impossible, to do more with the Spanish mackerel than impregnate the eggs and replace them in the water for nature to deal with.

I made several attempts to impregnate and hatch oysters, but soon came to the conclusion that we could do nothing in that line on shipboard, and was convinced from our own experiments and what I saw at

Professor Brooks's laboratory that success in that line could only be attained by handling on a large scale—that is, by having a large body of water in which a slight circulation could be maintained. I am glad to learn that Professor Ryder has proved this to be feasible.

On July 13 work was interrupted by the ship being driven ashore during a squall and was not resumed until the 21st.

I found that there were about 20 small seines fished during the summer on both sides of Cape Henry, the larger number being on the inside. I visited two of these, one on the bay and the other on the Atlantic side. The principal catch of the first was spots. The other took a great variety, including sheepshead and occasionally a few mackerel.

If the catch of these outside nets, especially those further south, were watched carefully, I think the runs of mackerel up the bay could be foretold with considerable accuracy.

On the 29th of July, at the request of the health authorities, I towed the hospital barge Seldon to Fisherman's Inlet and moored it. On August 3, went to Norfolk and shipped hatching outfit to Washington, and, on the 4th, started for Baltimore, arriving on the afternoon of the 5th. Had the vessel docked, overhauled, and filled with coal, and left again on Sunday, August 12, for Fortress Monroe, via Cherrystone Inlet, where I went to try and get one more lot of eggs. We overhauled five nets on the 13th, but got no eggs. Was delayed until the 17th in Hampton Roads by bad weather, but left there on the evening of that day. Arrived inside Sandy Hook at midnight of the 18th. Got under way on the morning of the 19th, and after sending ashore for possible mail in New York, proceeded through Hell Gate and up the Sound, anchoring off Bridgeport, Conn., at 6.30 p. m. Got under way again at 7.20 a. m. of the 20th, and arrived at Wood's Holl at 8.55 p. m. that day.

I append a table giving a record of the hatching operations and all data in the way of temperatures, winds, &c., that could have affected the results.

U. S. FISH COMMISSION STEAMER FISH HAWK,

Wood's Holl, Mass., September 6, 1883.

Record of mackerel hatching on board U. S. Fish Commission Steamer Fish Hawk, season of 1883, Lieut. W. N. Wood, U. S. N., commanding.

Date.	Station.	Fishery.	Kind of fish.	Number of— Males.	Number of— Females.	Number of— Eggs taken.	Time of impregnation.	Time of hatching.	Number deposited.	Why not deposited.	Wind.	Temperatures. Air.	Temperatures. Water.	Temperatures. In aquaria.
1883.												°		°
June 21	Fish Hawk	Pickett's Hole	Spanish mackerel.	2	1	500,000	10 a. m	(*)	(*)		S. and E	84	80	74
21	...do	New Point	...do	1	1	1,500,000	3.30 p. m	(*)	(*)		...do	84	80	74
22	...do	York River	...do			(†)					SE. to ENE	83	80	75
23	...do										N. and E	85	79	74
24	...do										NW. to SSE	89	78	
25	...do										S. and E	87	77	
26	...do										...do	83	80	
27	...do										...do	84	80	
28	...do	York Spit				(†)					WSW. to ESE	92	79	
29	...do	Butler's Bluff				(†)					S. and W	88	81	
30	...do										South	96	81	
July 1	...do										NE. to ESE	77	80	
2	...do	Butler's Bluff				(†)					S. to SSW	88	78	
3	...do	Pickett's Hole	Spanish mackerel.	2	3	1,000,000	10 a. m	July 4	250,000	Died	SW	94	81	75
4	...do										SSW	91	82	77
5	...do										...do	84	81	78
6	...do										S. and W	95	81	78
7	...do	Pickett's Hole	Spanish mackerel.	1	1	500,000	12.30 p. m	July 8		Died	...do	92	91	79
8	...do										...do	91	84	77
9	...do	York River				(†)					SW. to NE	77	82	77
10	...do										NE. to ESE	77	82	76
11	...do	Mouth of Cherrystone Creek.	Spanish mackerel.	1	1	500,000	5.30 p. m	July 13		Died July 14.	S. and E	88	81	77
12	...do	...do	...do	2	2	500,000	9 a. m	July 13		July 14	...do	85	79	74
13	...do	...do				(†)					N. and W	85	79	77
14	...do										NNW. to ESE	95	83	
15	...do										...do	95	81	
16	...do										NW. to ENE	98	83	
17	...do										S. and W	91	82	
18	...do										N. and E	86	83	
19	...do										...do	87	83	
20	...do										WNW. to SE	90	83	
21	...do	Cherrystone Creek				(†)					SE. to SSW	85	80	
22	...do	...do				(†)					S. and W	92	82	
23	...do	...do				(†)					SW	94	85	
24	...do	...do	Spanish mackerel.	4	4	2,000,000	1.45 p. m	July 25	Died	July 26	SW. to NNW	94	85	76

* Unimpregnated.

† No eggs obtained.

Record of mackerel hatching on board U. S. Fish Commission Steamer Fish Hawk, &c.—Continued.

Date.	Station.	Fishery.	Kind of fish.	Number of— Males.	Females.	Eggs taken.	Time of impregnation.	Time of hatching.	Number deposited.	Why not deposited.	Wind.	Temperatures. Air.	Water.	In aquaria.
1883.												°	°	°
July 25	Fish Hawk	Plantation Creek				(*)					SW. and NE	79	77	75
26	do	Cherrystone Creek				(*)					NE. to SE	83	77	72
27	do	do				(*)					SW	83	77	
28	do	do				(*)					do	84	76	
29	do										SSW	82	76	
30	do										ENE	79	78	
31	do										NE. to SE	89	79	
Aug. 1	do										SSW. to SSE	92	80	
2	do										SSE	94	80	
3	do										NE	95	81	
4	do										N. and E	83	78	
5	do										N. and W	85	78	
6	do										do	91	78	
7	do										SSE	85	78	
8	do										do	95	78	
9	do										NNE	93	78	
10	do										do	85	77	
11	do										do	94	78	
12	do										N. and W	96	77	
13	do	Cherrystone Creek				(*)					S. and W	90	76	

* No eggs obtained.

XXXIV.—REPORT UPON APPARATUS AND FACILITIES NEEDED FOR HATCHING SPANISH MACKEREL.

By J. ALBAN KITE, M. D.

I have the honor to submit for your consideration a report upon the following topics:

1. The best apparatus for hatching the eggs of the Spanish mackerel, as shown by my personal experience.
2. The most suitable station for conducting such work.
3. The best locality for station.
4. The necessary help and apparatus for conducting the work.

I will first go over the list of appliances we have used on the Fish Hawk. In July, 1881, the United States steamer Fish Hawk, under command of Lieut. Z. L. Tanner, United States Navy, made her headquarters in Cherrystone Creek, Virginia. The first eggs received were put into the Ferguson cones, which had been previously nickel-plated, to, it was thought, prevent the action of salt water. It took but a few hours to prove this would not answer, for the sulphate of nickel was formed and the fish died; besides the eggs when healthy float, and the current carried them against the gauze sides and aided in the work of destruction. Next we tried the eggs in a cylinder with a flat bottom and an intermittent flow of water maintained by a syphon. The cylinder was coated on the inside with asphaltum. Then copper cylinders with gauze bottoms were used over the side of the ship, and a rise and fall obtained by means of machinery. But in neither instance did much success attend our efforts; in the case of the cylinders over the side the movement of the waves dashed the eggs against the metal sides, the membranes were ruptured, and death ensued; had these eggs been free they would have freely ridden the waves with no discomfort. Next, Captain Tanner had a large block-tin cylinder, open at both ends, set in a tub of water; the eggs were placed in the cylinder and the water was delivered into the tub; nothing was used on the bottom of the cylinder to prevent the escape of the eggs, their buoyancy being found sufficient.

Things were progressing to our satisfaction, when a white scum was noticed on the surface of the water; this on analysis was found to be antimony; the metal had been used to form an alloy with the tin and

increase its strength. Many of the fish died, but, notwithstanding the baneful effects of the salts of antimony held in the water, the apparatus was so efficient that we were enabled to hatch out 50 per cent. of the eggs, and to keep the young fish for several days. The experiment was left unfinished when orders came for our departure. Yet our experiment taught us (1) to have, if possible, no metal come in contact with the water containing eggs or fish; (2) to give plenty of light; (3) that the eggs would not hatch properly when the temperature was below 78° F., nor could they survive a rise or fall of several degrees, even though the temperature was high.

In the summer of 1883 the United States steamer Fish Hawk, commanded by Lieut. W. M. Wood, United States Navy, made a cruise in Cheasapeake Bay to experiment with and devise an apparatus for hatching the eggs of the Spanish mackerel. A few eggs were obtained at New Point, but the larger part were taken on the eastern shore, at the mouth of Cherrystone Creek, near the light-house.

Mr. Smith and myself having had some experience, as related, requested that some half dozen glass aquaria be furnished, and we devised an apparatus of which an idea may be formd from Fig. 1. The aquaria

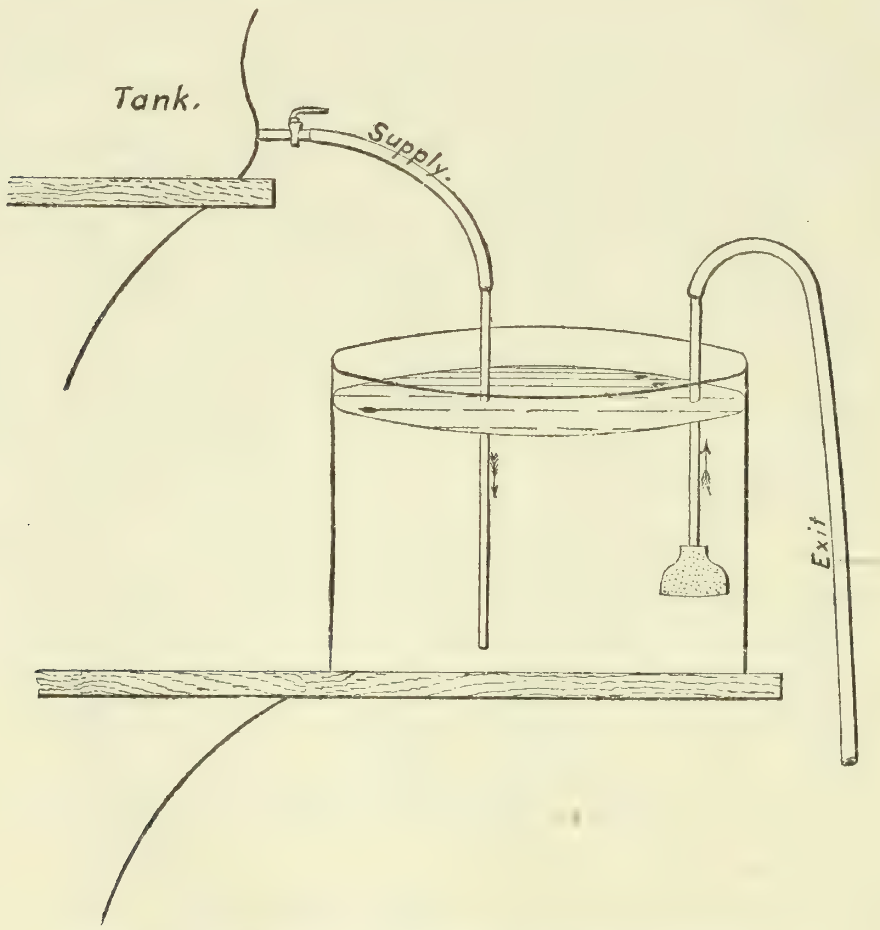


FIG. 1.—Aquarium for hatching Spanish mackerel.

gave us a large water surface with convenient depth, and into it from our tanks we allowed a flow of water; this was conducted from the tank to the aquaria by rubber tubing which passed over a piece of five-eighths-inch glass tube which in turn passed to the bottom of the

aquaria. The overflow was established by means of a syphon consisting of a glass tube that was inside the aquaria and a rubber tube that fell over the side and reached below the aquaria; to the lower end of the glass exit tube we affixed a strainer consisting of a wooden cone, and over the 3-inch opening fastened a plate of mica perforated by minute holes. We watched its operations with interest, and at first found it was all our crude ideas anticipated, and although we used a strong current of water, yet the floating eggs were not in the least disturbed. But after remaining in the water for some time the mica became very brittle and cracked. This would not do, so we substituted for the mica perforated tin coated with asphaltum, but the asphaltum did not coat the perforations, and these soon corroded, and the oxide of iron excluded the openings.

Later, at Mr. Smith's suggestion, we tried silk gauze, such as is used in making nets for surface towing, and by doubling this over the ends of the wooden cones prevented the escape of the eggs, but our trouble lay in the dead eggs rising and becoming entangled in the meshes of the gauze, thus preventing a free current, but this difficulty was easily overcome by occasionally freeing the surface with a feather.

The eggs hatched well, fully 60 per cent. of young fish appeared, and in 17½ hours after impregnation, with the temperature of the water at 80° F., a microscopic examination led me to believe had all the eggs placed in the aquaria been properly impregnated the percentage hatched would have been greater, but in taking the eggs it is impossible not to get some unripe ones. After hatching, the fish gradually died, and for a long time the cause was unexplained; finally we decided it must lay in the iron tanks used as receptacles for water. These tanks have been used to hold fresh and salt water for three years, and, though repeatedly scraped and painted, soon corrode; besides what now must have been suspended in the water we found large quantities, comparatively speaking, deposited in the bottom of a vessel where some of the water stood.

We had no good opportunity to test our conclusions, for later, when Captain Wood substituted a cypress tub as a receptacle, the cold nights destroyed both eggs and fish. Captain Wood also changed, in these later experiments, the form of apparatus by immersing into a vessel containing water a glass cylinder over whose lower end gauze was stretched; into this cylinder the eggs were placed. The entrance water either fell into the vessel outside the cylinder and fresh water was obtained by diffusion through the gauze or the water fell into the cylinder direct and passed out through the gauze; but in either case the eggs which settled caused much inconvenience by covering the gauze and preventing the free circulation of water. The cold, however, cut short our work.

This is a brief synopsis of my own observations, and although in the main our work was not a success, yet there appears to me evidence that with slight modifications our original apparatus will hatch the eggs of

C. maculata. I also believe the same design will work with cod or other floating eggs, and probably with much greater success, as the eggs are less delicate.

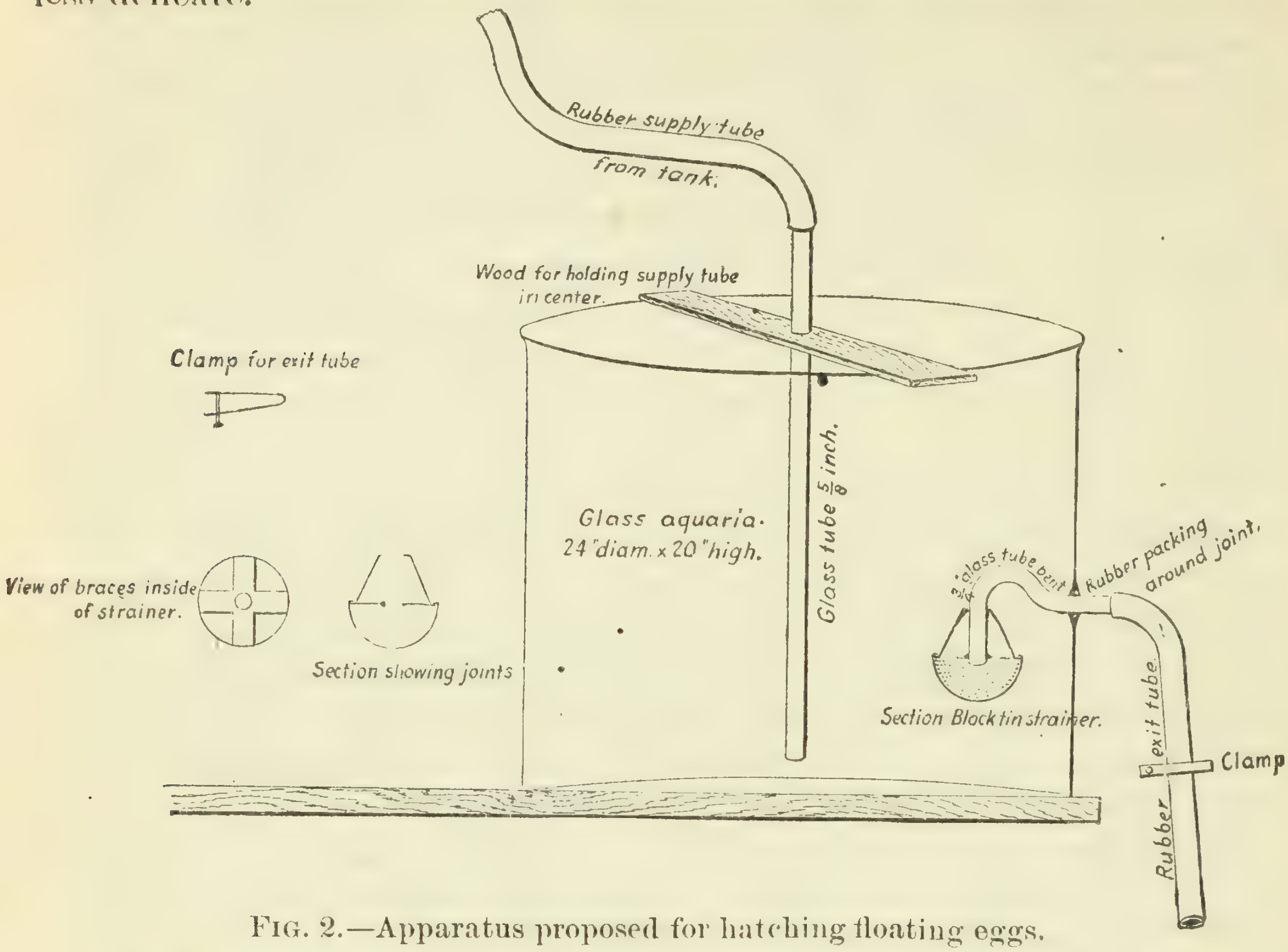


Fig. 2.—Apparatus proposed for hatching floating eggs.

As to the best apparatus I submit one shown in Fig. 2. I will describe the apparatus entire and name its advantages as they have appeared to me. It is drawn to a scale of 2 inches to the foot. The aquarium is to be of glass and 24 inches in diameter and 20 inches in height. A hole $1\frac{1}{2}$ inches in diameter is to be made on one side of the aquarium, the center of which is to be 8 inches from bottom of aquaria. Through this is passed a five-eighths-inch piece of glass tubing, having a caliber of one-half inch; this to be bent in manner shown; over the inner extremity of this a block-tin strainer is passed and attached. The strainer, as shown, has a depth of 4 inches, the lower 2 inches convex, the upper 2 inches in shape of a truncated cone, the apex 1 inch across the base, with a diameter of 4 inches; the two pieces to be soldered together, and, to prevent separation, the upper lip of convex portion is to be bent inwards at a right angle, and directly rest upon the lower border of cone, which is bent outward at right angles to receive it.

To prevent collapsing, two pieces of block tin 1 inch in width and one-eighth inch in thickness cross each other and have their extremities firmly soldered to the junction of upper and lower half of strainer on the inside. These at their center are perforated to admit the extremity of three-fourths-inch glass exit tube. The truncated portion of cone may be made to fit the glass tube very tightly by rubber packing. The joint where the glass exit tube passes through the side of the aquaria must

also be made tight by rubber packing. The strainer must be made of pure block tin, and the convex portion perforated by holes one-fortieth of an inch in diameter, these holes to be as close together as the strength of the tin will allow. To the extremity of strainer tube may be attached rubber hose, which conveys the water off. The glass entrance tube passes through a piece of pine wood, so notched as to keep the tube in the center of the aquarium. The clamp for exit rubber tubing may be made of spring brass, and at the extremity have a thumb-screw for adjusting.

I might add that an advanatge will be found in having the aquaria of the above size, which are large enough for several million Spanish mackerel eggs, but were they larger it would be difficult to establish a sufficient current of water, while it would be increasing the number of aquaria needed if they were made smaller. All the parts, as you may see, are such as may readily be replaced and fitted at the station. Experience has not demonstrated the truth of the opinion that this form of apparatus will serve for cod hatching, but the probability is so great that a trial at least might be made, with reasonable hopes of success.

Mr. Barry suggests an automatic arrangement to keep the water at a certain height, but I see no need of additional complications. The advantages of this glass aquarium, arranged as described, may be summed up as follows:

1. It is inexpensive, and all the parts are easily duplicated.

2. It furnishes a regular supply of water, the amount at our command.

3. The eggs float without being in the least disturbed.

4. The perforated surface of the strainer looks downward, and its circular slope prevents clogging by eggs or dirt; if such, however, collect, a feather readily removes without disturbing the good eggs.

5. It is entirely of glass, save the strainer, which is of block tin, and not influenced by salt water.

In using the above apparatus the eggs may be introduced after they have come up, care being taken by changing the water to free them from sperm, which readily decays. After the young fishes are hatched, they should be carefully siphoned into another vessel and the supply of water immediately established, for the young fish need a greater amount of fresh water than the eggs. I think it best to change on hatching, for by this means we free the fish from the influence of the egg membranes, which decay.

Although light is absolutely necessary for the healthy development of the egg and young fish, yet at no time should the sun shine directly upon them. This may do in nature, but in our artificial work the small body of water is heated, which must fall at night, subjecting the fish to a change they can only occasionally survive. I might also add, the mackerel are believed to spawn most freely in the afternoon, and if this be true, 18 hours later the fish would be ready to hatch, and the sun would not yet have acquired much power.

1. Respecting the most suitable station for hatching, I would advise on shore. It will require less men and less money to carry on; the matters of temperature (equal) and light are more at our command.

2. The best locality for a station is on the eastern shore. This is explained by the prevalence of southerly and westerly winds, which drive the fish to the eastward. The fact is apparent to the fishermen, and this their explanation. In conversing with Mr. Smith he informed me, "There exists no more favorable spot than at the mouth of Cherrystone Creek. There are several pound-nets in this locality, with a light-house to serve as a station." Under the light-house proper are a series of braces which serve to strengthen the structure, and on these a floor is often laid, where the keepers raise plants, &c. Now, this floor is just the thing, and canvas sides can be readily arranged, to raise or lower at will. There is always a vacant room in the light-house. If this place meet not with your approbation, by next summer a wharf is to be built at Plantation Creek, on which a station could be erected.

3. All the apparatus needed for the work would be a large tank, with a hand-pump to fill it with water; four men to stand watch and visit the nets and secure eggs. And I believe that if the men are permanently there during the season, all the eggs necessary for the work can be obtained. A superintendent will also be needed to direct movements and institute changes, if necessary, in the working of the apparatus.

As to the time of fishing the nets, this will depend alone upon the convenience of the "run" boats that carry the fish to market. I might add, the spawning of the fish begins about the middle of June and lasts until the latter part of August, or such our observations taught us this summer, and this also was the opinion of the fishermen themselves.

WOOD'S HOLL, MASS., *August* 23, 1883.

XXXV.—UTILIZING WATER BY FISH-CULTURE.*

By PROF. B. BENECKE.

ANALYSIS.

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I.—INTRODUCTION.

While for many years the greatest activity has been displayed in the various branches of agriculture, with the view to increase the productivity of the soil by improved methods of farming and stock-raising, by far too little attention has been given to the utilization of the water. It is a very common occurrence to see ponds, swamps, and small sheets of water lie entirely useless, to see marshy meadows produce a small quantity of almost useless grass, whilst in these very localities ponds could be constructed with very little trouble, which without great labor or capital would yield a rich harvest of fish. This is all the more humiliating, as our ancestors have in many places carried on pond-culture in a systematic manner and with considerable success, as old chronicles

* "*Die Nutzung des Wassers durch Fischzucht*," by Prof. Dr. B. Benecke, of Königsberg. From "*Landwirthschaftliche Thierzucht*," Vol. IV, Nos. 119–133, Bunzlau, 1884. Translated from the German, by HERMAN JACOBSON.

show that many waste places centuries ago produced large quantities of fish, no pond or puddle, be it ever so small, being allowed to lie idle.

At this very time, when it is the principal object of land-owners to make the sale as productive as possible, when the fisheries in our inland waters are seriously injured by river improvements, by the pollution of the water through industrial establishments, and by reckless fishing; we have every reason to give our fullest attention to pond-culture, all the more as, thanks to the better means of communication, the sale of fish is no longer limited to the immediate neighborhood of the places where they are caught, but as fish can easily and cheaply be sent to considerable distances, an overproduction or a decrease in the value of fish is prevented.

Many a person will therefore welcome some brief and simple hints as regards the construction and proper management of ponds, especially if he is the owner of suitable land, and has a justifiable horror of voluminous manuals and expensive experiments.

By ponds we understand sheets of standing water of different sizes, which, if desirable, can be laid dry, and again filled with water. According to the source from which the water is supplied we may distinguish (1) brook-ponds, (2) river-ponds, (3) spring-ponds, and (4) sky-ponds. Brook and river ponds receive their supply of water from brooks and rivers which either flow through them or are connected with the ponds by means of ditches or canals. Spring-ponds have at their bottom or along their edges springs, which, if flowing very freely, make up for the loss of water from evaporation, and keep the water at an even depth, but if flowing very freely, cause a brook or river to take its rise from the pond. Sky-ponds are those ponds which, without having any supply of water from rivers and springs, are fed simply by the water from the atmosphere which either falls into them as rain, or flows into them from the surrounding higher ground. In accordance with this classification of ponds, these different kinds of ponds possess varying qualities which are either helpful or hurtful for certain purposes, and which have to be taken into consideration in making use of them. River and brook ponds possess the advantage of having a constant supply of fresh water, whereby the overheating of the water in summer and the suffocating of the fish in winter under a thick cover of ice is prevented. In other respects these ponds are unfavorable for certain purposes, because it is difficult or impossible, even by very narrow grates, to prevent young fish of prey and other enemies of the fish from entering the river or brook. Springs will prevent the overheating of the ponds in summer, but their temperature is frequently so low as to render them unfit for the same purposes, especially if the ponds are deep, and the flow of water from the springs is plentiful. If the water comes from a great depth, and does not before entering the pond pass through layers of soil containing air, it frequently contains so little oxygen that the fish are suffocated, especially under the ice in winter. In this respect

it is preferable to have the springs located at some little distance from the edge of the pond. If springs contain much iron, lime or different gases, they will make the water of a pond entirely unfit for fish-culture.

Sky-ponds share this advantage with spring-ponds, that, owing to the absence of a supply of water from a river or brook, they are tolerably well protected against enemies of the fish, although occasionally the spawn of pike and other fish is introduced into them by aquatic birds. During hot summers these ponds have the disadvantage that, especially if they are not very deep, the water easily becomes too hot, or even evaporates entirely. It is therefore a great advantage for sky-ponds if a number of water-pipes empty into them.

Ponds may be dug out, or, by using the existing grades of the land, be constructed in such a manner as to prevent the outflow of the water by means of dikes. This last-mentioned method may be specially recommended as being cheap and as the quickest way of reaching the object in view. In this manner large or small, deep or shallow ponds may easily be constructed in any country which is not absolutely level. By a skillful use of the ground small sheets of water measuring but a few meters in length will suffice for the construction of large ponds.

For centuries pond-culture has been almost exclusively devoted to the raising of carp, which owing to its rapid growth, its hardiness, its quick increase, and its great and general popularity as a food-fish, is on the whole the best paying fish for pond-culture. We shall, therefore, principally treat of carp-culture, and afterwards give a brief review of the raising of other fish in ponds.

A distinction should be made between fish-*culture* in ponds and the *keeping* of fish. The former aims at increasing the number of fish and raising them until they have reached a sufficient size to make them marketable, whilst the latter confines itself to fattening the fish which have been obtained from fish-culturists when quite young. Any pond or puddle having suitable water, and a depth of ½ to 1 meter, is suitable for the keeping of fish, even if there is no chance to let the water off; whilst regular fish-culture in ponds requires a number of different and properly arranged ponds.

It will be best to construct carp-ponds in the midst of fertile fields, surrounded by gentle hills, protected against the east and north winds and quite open towards the south, so that during the day the sun may shine on them and heat them. The most favorable bottom is clay, which does not allow the water to filter through into the depths of the ground, and which offers the greatest advantage for the development of rich fish-food. Marshy or sandy bottom is not so good; the latter especially is very poor and particularly apt to let the water filter through, unless the entire bottom of the pond is covered with a thin layer of clay. Shallow ponds are preferable to deep ones, because the production of fish-food does not depend on the quantity of water, but on the extent of the bottom, and because deep ponds do not so easily reach the desired de-

gree of temperature, and also require very high and broad and consequently expensive dikes. If ponds are constructed on strongly-sloping ground, it may be recommended to construct several small and shallow ponds, one above the other, in preference to one large pond which would be very deep on one side.

II.—CONSTRUCTION OF THE PONDS.

As a general rule it will only pay to construct ponds that need but few earth-works. The best way is to use broad and flat valleys, with a gentle fall, whose sides are high enough to prevent an injurious overflow of the water into the surrounding fields, and which in some places approach so near to each other that it needs only short dikes to connect them. Such gentle valleys are found in nearly every part of the country, unless it is absolutely level, and frequently they produce nothing but a small quantity of sour grass. Frequently they extend with a gentle fall for a considerable distance, so as to make it easy to construct a number of ponds one above the other, which is particularly advantageous, because small and shallow ponds are, as a general rule, much more productive than large and deep ponds. In that case the ponds can easily be drained, beginning at the lowest one, and be filled again from the highest one. (Plate I, Fig. 1.)

In such valleys it will be easy to find the most suitable place for the principal dike after, by simple leveling, the fall is ascertained and thereby the size of the pond is determined. The pond is of course deepest next to the dike, and gradually grows shallower towards the other side. For most purposes it is best not to exceed an average depth of 2 meters; as a general rule ponds having an average depth of 0.50 to 1 meter are the best; the outflow of the water must be carried though the dike, and a ditch of sufficient breadth and suitable fall must be supplied for it.

The dike may be constructed of different material. The simplest and cheapest are earth-dikes which meet all requirements, and which can be constructed without hiring foreign laborers. We shall therefore confine ourselves to a description of such earth-dikes. Even in wood and stone dikes the main body of the dike is made of earth, which towards the side of the pond is protected by a wall constructed of stones or cement or of beton. The principal use of such walls is to protect the dike against the action of the waves in large ponds, whilst in small ponds this protection may be obtained in a much simpler and cheaper manner.

The best material for constructing the dike is clayey soil which does not contain much sand. Wherever such soil cannot be obtained, except by going a considerable distance, the main body of the dike may be constructed of gravel or some other material, and be made water-tight by a layer of clay 20 to 30 centimeters thick, which is either placed on the side of the dike toward the pond, or is made inside the dike whilst

it is being constructed. A gravel or sand-dike of course resists the *pressure* of the water as much as one constructed of clay, and all that is necessary is to prevent the water from *oozing through* by providing a strong layer of clay. The first work is to stake off the sole, or foundation, of the dike, and clear away all grass, shrubs, &c. The same of course applies also to the edges of the valley on which the dike is to rest. If by this work an impenetrable foundation has been laid bare, the construction of the dike may be commenced at once, but if marshy soil or gravel has been brought to light, it will have to be removed along the entire extent of the ground which the dike is to cover, until firm, impenetrable soil is reached, because otherwise the water would ooze through below the dike, thereby occasioning not only a gradual decrease of water in the pond, but also the slow but sure destruction of the dike. As soon as suitable soil has been reached along the entire extent of the dike, it is well, especially in dikes which are not very broad, to dovetail the dike with the foundation. For this purpose two or more ditches are dug along the entire length of the proposed dike and parallel with its edges, measuring about 50 centimeters in breadth and depth; the bottom of these ditches is made broader that the top. Only after these ditches have been filled with the same material of which the dike is to be constructed, which is well rammed down, the construction of the dike is commenced. If the main body of the dike can only be constructed of gravel or other porous material, the ditch nearest to the waterside should be filled with clay, and, as the building of the dike progresses, the layer of clay, referred to above, should be begun on this ditch and continue through the entire dike.

It is of the utmost importance for the durability of the dike to give it the proper degree of consistency and shape. The sole of the dike must be twice as broad as the proposed height of the dike, and the top of the dike should be half as broad as it is high. The slope and sole should, therefore, form an angle of about 50 degrees. Steeper slopes are not to be recommended, and there may be circumstances which make it advisable to have an angle of only 45 degrees. The height of the dike will, of course, be regulated by the proposed depth of water. To avoid any damage to the top of the dike it may be well to make it a meter higher than the normal height of the water.

It is important to select a suitable season and favorable weather for constructing the dike. If the material is to gain some consistency, the work must not be done in frosty weather, nor when the weather is very damp. If it is unavoidable to work during wet weather, the material of which the dike is constructed must be thoroughly rammed down, which, of course, is hardly necessary when the soil that is heaped up is dry and loose. To guide the workmen the outlines of the dike must be staked out at distances of 2 meters by poles and laths. (Plate 1, Fig. 2.)

It is absolutely necessary to have the work properly superintended;

care should also be taken that no wood, roots, and other articles get in the dike, which would gradually decay and cause the dike to shrink in some places, thus diminishing its firmness, and making it possible for the water to enter. Along the scarps and on the top of the dike the soil must be well beaten down, or rammed down. After the dike is finished it will take it some time to settle. No water should be let into the pond till one-half year after the dike has been completed; and if the dike is large, one whole year should be allowed.

While the earth of which the dike is constructed is heaped up, the outflow pipe, to which I shall refer further on, must, of course, be inserted and well rammed down in a bed of clay.

To protect the dike it is absolutely necessary to cover its scarps. The simplest way to do this is to use square pieces of turf, cut regularly, measuring from 30 to 40 centimeters on each side, and 10 to 15 centimeters in thickness. For this purpose thickly-grown turf should be selected, with short fine grass, taken from black meadow-soil. The sod had best be cut in moderately moist weather, and be laid, beginning at the sole of the dike and progressing towards the crest, in such a manner that the different pieces are joined closely together, the perpendicular sides of the pieces of one row always standing in the middle of the pieces of the contiguous row, on the same plan as bricks are laid (Plate I, Fig. 3).

The lowest row is embedded in the ground. On the pond side of the dike, which to distinguish from the other side or the back is generally called the front, it is well to make the cover of the dike up to the level of the water of fibrous peat, wherever such can be obtained, as the grass will generally die under the water, and the decaying of its roots will tend to loosen the soil of the dike. The pieces of peat may be cut larger and have a thickness of about 10 centimeters; they will form a strong and durable cover which is not liable to decay. Both sod and peat are fastened to the dike with pegs. For this purpose it is advisable to use live branches of the basket willow, which soon take root and cover the scarp with a dense growth of willows whose branches may be cut at stated times and be used for wicker work (Plate II, Fig. 4). The best willows for this purpose are the *Salix viminalis*, and for sandy or gravelly dikes the *Salix caspica*. To keep the dikes in good repair, it is necessary to examine them frequently, and immediately to repair any damage, however small. Whenever the water has been let off, the scarps of the front of the dike should be carefully examined, and repairs made at once wherever needed.

The bottom of the pond should slope towards its deepest place near the dike, and should be as smooth as possible. Holes in which the water might be retained, when the pond has been drained, should be filled up as much as possible. A porous bottom can be made impervious by placing on it a thin, even layer of clay. In large ponds a well-defined pit of even depth (the fish pit) should be dug close to the dike;

and the lower part of the outflow pipe should be on a level with the bottom of this pit. To make the pit more durable, its sides are frequently lined with boards, and from it a ditch, gradually growing shallower, should extend the entire length of the pond. In very large ponds smaller ditches should start from the main ditch on both sides, forming a sharp angle with it (Plate II, Fig. 5).

When the water is drained off, the fish will gradually retire to these ditches and thence to the fish pit, where they can be caught with very little trouble. As a protection against fish thieves, it is well to drive into the bottom of the pond small posts at intervals of a few meters, which should protrude 20 to 30 centimeters above the bottom, thus preventing the use of drag nets. The best posts for this purpose are young pine trees, which are freed from their branches and driven into the ground at the thin end, a few centimeters of the branches being allowed to remain round the top (Plate II, Fig. 6). If no pine trees can be obtained, simple posts are driven into the ground and a number of nails fastened to the top, whose heads, however, should not be very sharp, to prevent the fish from getting hurt.

The arrangements for the outflow of the water serve two different purposes: first to drain the pond either in part or completely, and second to take off superfluous water caused by sudden rains or brought into the pond from the ditches which supply the water.

The first purpose is served by sluices and taps, and the latter by weirs and flood ditches.

In many of the older ponds one still finds sluices such as are used in mills (Plate III, Fig. 7). In new ponds it is not advisable to introduce them, as they require a good deal of carpenter's work, and easily get out of repair. They, moreover, have this disadvantage, that, even when they are only partly opened, the water rushes through the opening with full pressure corresponding to the depth of the pond, carrying with it fish and other objects, and if the opening is made larger carrying away parts of the bottom and sides of the outflow ditch.

The tap outflow (Plate III, Fig. 8) consists of a pipe of wood, clay, or masonry led right through the base of the dike, open at the end which is outside the pond, but closed at the one projecting into the pond. The width of bore of this pipe, which generally consists of a single trunk of an oak or pine tree, is as a rule 25 to 30 centimeters. In large ponds several such pipes are sometimes led through the dike side by side. At the end of the pipe projecting into the pond one or several meters, a conical hole of about 20 centimeters is bored in the top, which may be closed by a tap of the same size. This tap is connected with a strong pole which rises perpendicularly from the water. At equal distances from this pole (about 30 centimeters) four square posts are firmly driven into the bottom of the pond, which rise to an even height above the surface of the water, and to which horizontal beams are fastened by means of which the pole may be raised or lowered, and

be retained in any desired position by screws or bolts. Up to the surface of the water the four square posts are connected by horizontal laths, which form a grating with intervals of 2 to 3 centimeters. This is intended to keep out fish, leaves, &c. Above the surface of the water the posts are connected by closely-joined boards and protected on the top by a roof. This whole contrivance, which, in large ponds having several tap-outflows, assumes considerable dimensions, is called the tap-house (Plate III, Fig. 9). In order to show the tap-pole the upper boards have been left out of the drawing. Whenever the tap is raised the water flows into the pipe through the conical hole and through the pipe finds its way outside the pond. Fish are kept back by the grating. The tap-outflow is much cheaper than a sluice, but has the same disadvantage that the water from the bottom of the pond flows out at a high pressure and easily damages the outflow ditch.

Of late years such outflows are in large ponds constructed of masonry, and, instead of the taps, valves are employed which are raised by screws. But even these outflow arrangements have the above-described disadvantages.

The so-called "monk" or stand-pipe outflow (Plate IV, Fig. 10 and Fig. 11) is without doubt the best outflow arrangement. As in the tap outflow, a horizontal pipe is led through the base of the dike. This pipe may be constructed of masonry, but generally it is made square in shape, of strong oak boards, which are carefully joined and thoroughly embedded in tough clay. The height of the opening is generally 20 to 30 centimeters, the breadth the same in small ponds, whilst in large ponds it may be much larger; in this case, however, strong props should be inserted at intervals to support the roof of the pipe, and protect it against the pressure of the soil on the top. At the end of this horizontal pipe, which projects about 1 meter into the pond, a vertical pipe of the same diameter is fastened, which projects about one meter above the highest water-mark. This is, if necessary, supported by strong buttresses, and its side towards the pond is open from top to bottom (Plate IV, Fig. 11). On the inside of the side planks two thin, but strong, strips are nailed down, which form a deep and broad groove, in which run a number of closely-fitting boards, measuring 15 to 20 centimeters in height (Figs. 10 and 11). By the pressure of the water these boards are pressed against the inner side of the groove, which should therefore be very broad, fastened firmly, and—as well as the boards themselves—be planed down very smoothly. The boards, however, should have room enough in the groove to prevent their sticking fast and make it easy to remove and insert them again. If broad "monks" are used, the side planks must of course be firmly joined by horizontal beams on the side towards the pond. In order to prevent the bending of the boards through the pressure of the water, the horizontal pipe should be divided into two halves by a strong board, so that the center of the boards meet with a firm resistance in this partition wall (Plate IV, Figs. 12, 13). In the center of

every board a strong ring of galvanized iron is firmly fixed by screws, so that the boards can easily be raised with a hook. It is not advisable to make these boards higher than 20 centimeters, as in that case they are difficult to handle, and whenever a board is raised the water rushes into the "monk" with too great force. The very circumstance that the water always flows off at the top, and consequently flows off with little pressure, thus neither carrying fish away with it, nor injuring the bottom or sides of the outflow ditch, is one of the principal advantages of this arrangement. Another advantage is this, that by means of the boards the level of the water can easily be brought to the desired height, at which it will remain; and when the opening of the "monk" is sufficiently large, even large masses of water, occasioned by violent rains, are easily led out in a very short time. To exclude the possibility of the fish escaping, a grate of galvanized iron is inserted in a wooden frame above the upper board. To prevent any unauthorized person from meddling with the boards, the top of the "monk" is closed by a lid on hinges. To prevent the stopping up of the grate by aquatic plants, dead leaves, and other articles of the kind carried along by the current, which mostly float on the surface, or immediately below it, it may be recommended to place a box constructed of two boards joined at a sharp angle in front of the pond side of the perpendicular outflow pipe. This box should rise 20 centimeters above the highest water-mark and be as far distant from the bottom of the pond. The water will then unhindered flow into the "monk," whilst all objects floating on the surface will gather in the box, whence they can easily be removed from time to time. After it has been ascertained what time it takes the level of the pond—after one of the boards has been removed—to sink to the edge of the next board, one will always know in what time the pond can be drained, which is of considerable importance, as sometimes the fisheries have to take place at a certain time.

The outer end of the horizontal outflow pipe (both in the "monk," and in the tap outflow), after it has left the dike, is generally extended 1 to 2 meters, in order to prevent damage to the dike such as being washed out from below. It will also be well to cover the first 5 to 10 meters of the bottom of the ditch with stones to prevent the ditch from being washed out, which might easily cause its walls to tumble down.

As wooden pipes will keep best when under water, it is advisable to place a small sluice in the outflow ditch, high enough to keep the outflow pipe under water all the time. When the pond is drained this sluice must, of course, be removed, so that the bottom of the pond may be laid entirely dry.

In ponds located in level country "monks" of suitable width will suffice to quickly lead out the superfluous water and maintain the normal level of the pond, even during violent rains or when the snow melts in spring. Ponds located between mountains or hills, or those fed by brooks or rivers which are apt to overflow, must be protected against

inundations and consequent injuries to the dike by weirs or ditches for carrying off the superfluous water.

The weirs (Plate V, Figs. 14, 15), are generally constructed at one end of the dike where, owing to the less depth of water, they are not exposed to any high pressure. According to the size of the pond and the probable quantity of superfluous water, the breadth of these weirs varies from 3 to 10 meters or more. The edge of the weir should, according to circumstances, lie ½ to 1 meter lower than the crest of the dike. The scarps, which in that part of the dike where the weir is constructed should not be near as steep as in the rest of the dike, meet in the edge of the weir in the shape of a roof, and are covered with thick boards closely joined together. The side walls of the weir must also be supported by firm buttresses. If the top of the dike is to be used as a road, a bridge should be thrown across the weir.

To prevent fish from being carried over the weir in high water a grating is placed upon it, or in front of it (Plate V, Fig. 14 *a*), generally of wood or galvanized iron (Plate V, Fig. 16), which in broad weirs runs parallel with the edge of the weir, but in narrow weirs is generally placed at a sharp angle against the current (Plate V, Fig. 14 *b*) so as to give more openings for the water to flow out, and to prevent leaves, &c., from stopping up the passage. If this nevertheless should happen, a floating beam (Plate V, Fig. 14 *c*) or a strong board is fastened in front of the grate obliquely against the current. Such a beam, or board, will stop all objects floating on the surface, and drive them towards the shore, where they will accumulate and whence they can easily be removed.

Wherever rivers or large brooks flow through ponds, it will be well to construct weirs in them before they enter the pond, so that the high water and the mud, &c., which it is apt to carry with it, do not enter the pond at all. To prevent the fish from escaping from the pond into the river or brook, its mouth should be closed by a grating or by a brush weir. Brush-weirs are made of fascines of thin brushwood measuring from 1½ to 2 meters in length, which are laid in the direction of the current, and must protrude about one-half meter above the highest water-mark. It will also be well, in order to prevent any stoppages, to place a floating beam in an oblique direction in front of the brush weir.

Ditches for carrying off the superfluous water are particularly required in ponds located in glens or valleys, so as to catch the snow and rain water flowing down from the heights, which generally carries with it sand, gravel, &c., and would soon fill the pond with its accumulations. Such ditches should, therefore, as a general rule be constructed parallel to the edges of the valley and of the pond, and should be broad and deep enough to contain and carry off all the superfluous water which may reasonably be looked for. Such ditches may also be required for catching and carrying off injurious water from places where flax is rotted, or from tanneries, dye establishments, and other factories.

III.—FILLING THE PONDS.

After the construction of the pond has been completed, and the dike has become thoroughly settled, the pond may be filled with water. New ponds whose dikes have not yet been tested had better not be filled to the desired height at once, but gradually. In sky ponds it will of course take the water a longer time to gather, and in order to have them full in spring, water should be allowed to gather in them in autumn. Wherever the quantity of water needed for filling the pond can be obtained at any time from springs, brooks, rivers, or lakes, it is advisable, for reasons to which we shall refer later, to let the bottom of the pond be dry during winter and until a short time before the pond is needed for use.

The filling of the pond is done by closing up the outflow-openings, either by closing the sluice, by putting in the tap, or by placing the flood-boards in the "monk," according to circumstances. In sky-ponds, and those ponds whose supply of water is scant, every opening should be firmly closed, so as to prevent a loss of water, which, in connection with the loss occasioned by evaporation, might easily prove very injurious to the fish. The tap should, therefore, be driven in firmly, and if necessary closed up with clay. The boards should also close firmly.

Even in filling the pond, the "monk" proves superior to all other outflow arrangements, as it allows the level of the water to be raised quite gradually. For various purposes, however, it is of great advantage to keep the water of the pond low in the beginning, and to have no more water in it after it has been in use for some time.

IV.—THE MANNER OF USING THE PONDS.

For a complete fish-cultural establishment different kinds of ponds are needed—spawning-ponds for propagating the fish, raising-ponds of the first and second class for fish one and two years of age, ponds for older fish (growing-ponds), winter-ponds for wintering fish of different ages, and stock-ponds for keeping the fish which are intended for sale.

1. The spawning-ponds.

Good spawning-ponds form the basis of well-regulated carp-culture. These ponds should be of such a character as to offer to the fish the most favorable conditions for spawning, and to favor as much as possible the development of the eggs and the young fish.

The best spawning ponds are small sky-ponds having an area of only one-tenth and, at most, one-half hectare. The bottom of these ponds should be impervious clayey soil or a clayey sand soil. Wherever it is impossible to construct suitable sky-ponds, ponds fed from rivers or lakes may be used; before entering the spawning-pond the water should, however, be filtered through large pits or boxes filled with coarse, washed

gravel, so as to prevent, as much as possible, fish and other injurious animals from entering the pond. Even sky-ponds are allowed to lie dry during winter, in order to destroy frogs, small crustaceans, insects, &c., and are only filled a short time before they are stocked. When a pond is known to contain much vermin, it is advisable to cover the bottom in autumn, after the fisheries have come to a close, with coarsely-grained lime. This will kill all vermin, and after the lime has been slacked, it is of course not injurious to the fish. To lay the pond dry during winter has also this advantage, that the soil by freezing becomes loose and loses its acidity. The pond should, therefore, be crossed by one, or, if the pond is large, several ditches, one meter deep. The depth of the pond should be from 20 to 30 centimeters, and the edges should be very shallow, with a thick growth of *Glyceria fluitans*, on whose floating leaves the carp like to deposit their spawn. As heat is one of the principal conditions for spawning and for the development of the young fish, the spawning-pond should be in a sheltered location, and entirely exposed to the sun, so that it can quickly be heated through. It is necessary that the pond should be protected against wind, so as to prevent the formation of waves which would kill the spawn deposited on the shallow shores. The depth of water should be as even as possible during the spawning-season, as its lowering would lay the eggs dry and kill them. Hurtful birds, such as herons, ducks, and geese, should be kept away from the pond; no cattle should be watered in it, as they would either devour the spawn with the floating leaves of the *Glyceria fluitans* or kill it by treading on it. Frogs also devour large quantities of young fish. Considering the importance of the spawning-ponds for the entire carp-culture, and their small size, it is advisable to surround them with a close wire-fence.

The spawning-ponds should not be stocked with spawning carp until the water has reached a temperature of 15° to 20° C. The spawners should already be selected in autumn when the fisheries are in progress. During winter they are kept in a good winter-pond; in spring they are examined once more, and the sexes kept separate in deep basins until the spawning-ponds are ready for stocking. As with the raising of any animals, so also with the carp, the selection of exceptionally good spawners is of the utmost importance. Although under favorable circumstances good fry may also be obtained from old carp, young carp, weighing from 2 to 4 kilograms, are preferable. It is advisable to select from among the fish of the same age the largest and best shaped, having a small head, a broad back, and slender body. The sexes can easily be distinguished during the autumn fisheries. As a general rule the belly of the spawner is, especially in its lower part, broader and rounder, the genital aperture appears larger and reddish, and has thicker lips, while with the milter it forms a narrow slit. It is a great mistake to press the fish for the purpose of ascertaining their sex, so much as to squeeze out immature milt or spawn. Such a procedure frequently

makes the fish sick and incapable of propagation. Any person using such rough methods should keep away from fish-culture.

Opinions differ as to the number of spawning fish to be placed in a spawning-pond of a given size, and as to the proportion betwen the sexes. If all the other conditions are favorable good results may be obtained by different methods. Of late years the common practice seems to be to count per hectare 8 to 10 spawners and 4 to 6 milters of the same size, in addition to which 2 to 3 small milters are put in the pond. For a spawning-pond of $1\frac{1}{10}$ hectare one would, therefore, take one spawner, a milter of the same size, and a smaller milter or two milters of somewhat smaller size than the spawner. If these fish are taken from a basin with cool water, and placed in a spawning-pond, whose temperature has already reached 15° C., one may with tolerable certainty count on the spawning process taking place on the following day or the day after. The spawning process generally takes place during the early morning hours. If you approach the pond cautiously about that time you may see the fish swim splashingly round the shallow shores, where they deposit their spawn on plants, or on juniper branches, which for that purpose have been laid in the water, and which may also be used for shipping the spawn. The eggs which are deposited by the spawners, and which adhere to aquatic plants, are impregnated by the milt which is ejected by the milters, and which by the violent movements of the fish is thoroughly incorporated with the water. After a while the eggs may be seen covering the leaves and stalks of aquatic plants in large numbers, and resembling transparent or slightly yellow beads of the size of grains of mustard. The number of eggs deposited by a spawner varies according to its size from 300,000 to 700,000, of which of course, especially in large ponds, a large number perish, so that it must be considered a favorable result if 1,000 to 1,500 young fish are produced in autumn from every spawner. In small spawning-ponds, managed in a rational manner, however, it is possible to obtain eight and ten times that number. Carp generally deposit their stock of eggs in three periods, separated from each other by intervals of eight or more days, so that in large spawning-ponds one may find young fish of three different sizes. In order to get the full benefit of the productivity of the fish, and to further the growth of the young fish, it will be found advantageous to catch the spawning carp after they have thoroughly spawned once in a small pond (which can easily be ascertained by examining the plants growing on the edge of the pond), in a fish-bag with long wings, and to transfer them immediately to another small spawning pond, where they will soon spawn again. From this pond they may be transferred to another spawning-pond, where they will spawn a third time. Another reason why it is advisable to remove the old carp from the spawning-pond is this, that they diminish the quantity of food intended for the young carp, and even devour some of the young fry with as much relish as they eat larva, worms, and tadpoles.

Any one who, without properly distinguishing the sexes, and without selecting carp of the proper size, simply places a number of carp in deep ponds for purposes of propagation, as is unfortunately still done in many places, need not be astonished if from numerous spawning carp he only raises a few sickly young fish.

From four to eight days after the eggs have been deposited, the young carp slip out of them and soon sport about in a lively manner among the leaves of the aquatic plants. The small umbilical bag which they carry with them from the egg is soon consumed, and the little fish will then begin to hunt for infusoria, very young larvæ of insects, crustaceans, &c. The quantity of food, however, soon becomes to small for the enormous number of young fish; and, under ordinary circumstances, a very large percentage perish very soon simply from lack of food, and the survivors do not grow as rapidly as would be the case, if they had ample food. The method practiced by Mr. Dubisch on the estates of Arch Duke Albrecht near Teschen, is therefore to be strongly recommended. It consists in gradually transferring the young fry raised in a small pond, and kept in it for a short while, to numerous other ponds, where they will grow rapidly and suffer but few losses. The first transfer is made five to eight days after the fish have been hatched. They are taken up with fine gauze-nets, collected in a floating tank with a wire bottom having very narrow openings, and thence are taken out in a small sieve, holding about 1,000, and placed in the transporting vessels. The ponds intended to receive these young fish are of the same character as the spawning-ponds. Until they are stocked with fish, they should, if possible, lie dry, so as to be free from enemies of the young fish, and full of fish-food. During the time that the young fry remain in the spawning pond proper—*i. e.*, as long as they have their umbilical bag, and even a few days longer—Dubisch counts 100,000 young fish to 3 hectares pond area of ponds of the second class (the pond to which the fish are removed from the spawning-pond proper). From data which he has furnished to Mr. Von dem Borne, it appears that the fish grew several centimeters in length in these ponds during a period of about four weeks, and decreased about 25 per cent. in number. They continued to grow well, after they had again been transferred to another pond. The spawning-ponds of the second class have previously been planted with some kind of grass, which has been properly harvested, after which they should lie dry for some time before being stocked with fish. They are stocked at the rate of 1,050 young fish per hectare, of which number there should remain in autumn 1,000 fish weighing one-quarter of a pound a piece. If these ponds are stocked with only 300 to 500 fish per hectare, they are said to reach the weight of one pound in autumn. Supposing, therefore, that in a spawning-pond proper of an area of 0.1 hectare a spawner had deposited 100,000 eggs, and that the young fish hatched from these eggs are distributed, after eight days, over a pond-area of 3 hectares, there would be 75,000 left after four weeks, which would be

sufficient to stock 71 hectares at 1,050 fish per hectare, and which would yield in autumn about 71,000 fish having a total weight of 8,000 to 9,000 kilograms.

On carp farms, managed in the usual manner, one is generally satisfied to get in autumn 1,000 to 1,050 young fish from one spawner, of which 100 will weigh 1 to 2½ pounds, therefore in all 5 to 19 kilograms, instead of the 8,000 to 9,000 obtained by following Dubisch's method.

Although Dubisch's data, which I have not yet had occasion to test practically, are surprising, I do not by any manner of means consider them improbable, as I myself have obtained in a very good spawning-pond, in which the majority of the fish perished by an accident, and where, consequently, there was an ample quantity of food for the survivors, young fish measuring 20 to 22 centimeters in length, and weighing as much as 150 grams. Dubisch's method seems specially important for populating lakes and rivers with these valuable fish, which, placed in them when measuring about 20 centimeters, will grow well, even if their number will not increase much in such waters.

It is a great mistake to place in large spawning-ponds, besides carp, other fish, especially crucians, as was formerly done quite frequently, and is still done in some places. Looked away from the fact that such fish, by diminishing the quantity of fish-food, will retard the growth of the young carp, the crucians will with the carp produce bastards, which have a high back, and are thin and full of bones. Such fish are the *Carpio Kollari* Heck., which will soon damage the reputation even of a good carp farm.

2. THE RAISING-PONDS.

"Raising-ponds" are those ponds in which the young carp are placed to grow. The young fish produced in the spawning-ponds are taken out either in autumn or next spring, and transferred to the raising-ponds.

This may be the proper place, in order to avoid repetitions, to give names for the carp of different age. Very strange names have been given to them in different places. Thus, people will speak of one year's, two years', and three years' fry, of spawning fry, of deposit, seed, &c. Some will call those fish three years' fry, which others call "one summer's fish," and the confusion of terms has become so great that when people speak of one year's carp they may mean carp of three months, as well as those of twenty months.

It seems proper to understand by "fry" those fish which have been hatched in spring or early summer, and call them by that name till autumn, or, since carp do not grow during winter, till next spring, or till they have completed their first year. The simplest way, however, is to distinguish the carp by the number of summers which they have passed, therefore, one summer's carp, two summers' carp, three sum-

mers' carp, &c. During the autumn of the year in which they are born and till the following spring, the carp are one summer's carp, in the following autumn and spring they are two summers' carp, &c. These terms cannot possibly be misunderstood. It will be much more inconvenient to distinguish the carp by the number of years, for in order to avoid confusion the two summers' carp would have to be called one and one-half year old in November, one and three-quarter year in February, two years old in May, &c.

As small fish do not flourish if put in one and the same pond with larger fish of the same kind, because they will thus be deprived of some of their food, it will be well to have different raising-ponds for carp of different years, whilst when the carp have grown to a larger size, it is no longer necessary to keep them separate.

One summer's carp are placed in spawning-ponds of the first class and two summer's carp in those of the second class. To accommodate myself to the terms employed in Dubisch's method, I have called those ponds to which the fish are repeatedly transferred during the first summer, "raising-ponds for fry," of the first and second class.

The raising-ponds proper of the first class should, if possible, resemble the spawning-ponds and "raising-ponds for fry" as to location and character. They may, however, be much larger, and cover an area of several hectares; in accordance with the size of the fish, their depth may vary from ½ to 1 meter. Their edges should be flat, and be planted with *Glyceria fluitans*. A moderate quantity of reeds (*typha*) and lilies (*iris*) on the edges of the pond will not only be an ornament, but also cause the development of various low grades of animals which serve as food for the fish. In raising-ponds fed by rivers and lakes, aquatic plants, such as *Potamogeton*, *Lemna*, and others, will soon make their appearance, which in moderate quantity are very desirable, but which should not be allowed to grow too rank. Raising-ponds may be used for watering cattle, as their dung deposited in the water favors the development of infusoria, insects, &c., and as there is no longer any danger that the fish will be injured thereby. No other fish besides carp should be allowed in the raising-ponds. According to the quantity of food contained in the ponds, from 300 to 800 one-summer's carp may be counted per hectare, which, if weighing 10 grams each when placed in the pond, should in autumn reach a weight of one-half to one pound. According to Dubisch's method, the raising-pond intended for one-summer's carp (which have reached a weight of one-quarter pound in the "raising-ponds for fry") is stocked with 520 fish per hectare. These, in the autumn, when their number has decreased to 500, should weigh 1 to 1½ pounds each.

The raising-ponds of the second class, intended for two-summers' carp, may be larger and deeper than the former class, and also contain more plants. As a general rule, they are stocked with from 200 to 400 carp weighing one-half to one pound per hectare, which in autumn will have

reached a weight of $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds. Dubisch counts 206 of his two summers' carp, weighing 1 to $1\frac{1}{2}$ pounds per hectare, and in autumn catches 200 fish weighing about 2 pounds. If only 154 carp per hectare are placed in the pond there should be in autumn 150 carp weighing as much as 4 pounds. It will not hurt to keep in these ponds, besides carp, some tench and eels, which root more in the ground than the carp, and there seek food which would be no good to the carp.

As with spawning-ponds and "raising-ponds for fry," it is also best if the raising-ponds are fished clear in autumn, and are allowed to lie dry during winter. Only in exceptional cases, and taking the proper precautionary measures, such ponds should be allowed to remain filled during winter.

3. Ponds for older fish (growing-ponds).

These ponds are intended for three-summers' carp, and here, according to the quantity of food contained in them, they will in one to two years reach a weight of 2 to $2\frac{1}{2}$ pounds. In Dubisch's method the raising-pond for two-summers' carp takes the place of the pond for older fish, no other pond being required, as it will be found most advantageous to sell the fish when they weigh from 2 to $2\frac{1}{2}$ pounds, because at a more advanced age they use the same quantity of food as younger fish, but produces less flesh. As ponds for older fish, large and deep sheets of water may be used, which, according to circumstances, are only fished every two years. As deep and cool waters produce less food for carp than shallow ponds, the ponds for older fish, especially if they are only to be fished every two years, should not receive as many fish as the raising-ponds, 150 to 250 per hectare generally being counted sufficient. It will not hurt to put a considerable number of tench and eels in these ponds. It is also advisable to place in these ponds a number of small fish-of-prey. Especially in ponds which are connected with other waters, there are generally found large quantities of fry of the bleak, the red bream, and other fish of this kind. Even into ponds which have no connection with other waters the spawn of such fish is frequently brought by wild ducks and other aquatic birds which often carry large quantities of it on their wings. These worthless fish, which only take away the food from the carp, ought to be destroyed by perch and pike, and thus be transformed into valuable fish flesh. It also frequently happens that in hot seasons the carp spawn already in the ponds for older fish, when of course the fry, being in cool water, and in the company of larger fish, do not develop well. Even such useless fry is to be transformed into valuable fish flesh by being devoured by fish-of-prey. This is the advantage of having "a pike in the carp pond," that it frees the carp from useless competitors for its food, whilst it grows quickly, and its flesh becomes particularly tender and well flavored. The old fables that the pike chases the lazy carp and forces them to take food, and that it pre-

vents the carp from spawning, because the female carp considers it use less to deposit any spawn, which would only fall a prey to the pike, ar no longer believed by any one.

As a general rule one puts with 100 three-summers' carp 5 small pike and, wherever they can be obtained, as many perch-pike.

As the ponds for older fish are well suited for wintering fish, an with the view not to crowd the winter-ponds too much, they are gen erally stocked in autumn at the time when fisheries are in progress i the raising-ponds. As the fish in them are only taken out to be sol they may be fished whenever it suits, either in autumn or spring.

4. WINTER-PONDS.

Winter-ponds are needed for wintering one-summer's and two-sum mers' carp, whilst the ponds for old fish are generally of such a natur as to afford a safe abode for fish during winter. The different raising ponds, even if they should be capable of wintering fish, should be lai dry every autumn, and their fish placed in the winter-ponds, as on th one hand it would be difficult to bestow the proper care in winter o a large number of ponds, and as, on the other hand, it thus become possible to destroy all the vermin in these ponds, and as finally i becomes necessary in a well-regulated pond-farm, to ascertain in au tumn how the fish in the different ponds have flourished. Good winter ponds are therefore absolutely needed in well-regulated carp *culture*, a in places where they do not exist one will have to confine oneself to th mere *keeping* of carp. On large pond-farms there should be several win ter-ponds for receiving carp of different ages and fish-of-prey. Th winter-pond should be in a sheltered location, have always the sam depth of water—2 to 4 meters—and if possible a regular supply of water Spring-water, which in winter has a higher temperature than river o brook-water, is to be preferred to the latter. Lakes and ponds ma also be used to advantage for constantly or temporarily feeding winter ponds.

The banks of the winter-ponds should have a steep slope, the botton must be firm, but neither hard nor muddy, and have a suitable depres sion (pit) in one place. In this place the carp gather, as soon as fros sets in, and remain there quietly, until the water again gets warmer sleeping more or less soundly according to the varying temperature o the water. Here they should be entirely undisturbed, as when the become scared they will swim around wildly, and in ponds whose bank are not very steep, get into shallow water, where they frequently freez to the lower side of the ice and thus perish. No persons or wagon should therefore cross the ice of the winter-ponds, and skating shoul be a strictly prohibited as well as the cutting of ice for ice-houses Every unusual agitation of the water by violent currents, which wil occur especially in spring, when the snow begins to melt, or during long

continued rainy seasons, likewise disturbs the carp and causes them to seek the surface, where frequently large numbers of them perish, if severe frosts set in late in the winter season. Winter-ponds located among hills should, therefore, in all cases be provided with ditches for carrying off the superfluous water.

Ponds which have a regular and abundant supply of water may safely keep their fish during an entire winter without air-holes in the ice. It is, however, advisable even in such ponds (as it is necessary in ponds whose supply of water is scant) to make 3 or 4 large air-holes at some distance from the fish-pit. These holes should be kept open all the time so as to admit air into the water. The freezing of these holes may be prevented by sticking into them large bunches of straw in a perpendicular position. It is still better, after a firm cover of ice has formed on the pond, to lower the level of the water from 10 to 20 centimeters, so that extensive places filled with air may form near the banks under the ice which slopes towards the center of the pond. In these air-holes, which should be examined every day, there will show themselves, wherever any deterioration of the water has taken place, gas-bubbles of different size, rising from the bottom, dead beetles, and other insects; the water will gradually assume a dingy color, and the fish will come to the surface trying to catch a breath of air. If aid cannot be afforded, by quickly airing the water or renewing it in part, the ice should at once be broken all over the pond, and the water let off, so as to save at least some of the fish by transferring them to other winter-ponds.

The airing of a pond is done in the most primitive manner, by repeatedly and violently pushing into the water large brooms or pieces of wood or leather fastened to long poles. A more satisfactory method, however, is to use a force-pump, whose hose is led to the bottom of the pond. In order to distribute the air in as many small particles as possible, the end of the hose is filled with a sponge, through which the air escapes in numberless small bubbles.

As winter-ponds are only used for harboring carp at a time when they do not take any food whatever (their loss of weight being only 2 to 3 per cent. during this period, owing to the pause in all the functions of life) they can receive quite a large number of fish—all the more the more abundant the supply of air and water. More small than large fish may of course be placed in the same pond area. As a general rule one may count per hectare 50,000 to 100,000 one-summer's carp, 30,000 to 40,000 two-summers' carp, 15,000 to 20,000 three-summers' carp, and still fewer older carp.

The carp had best be removed from the winter-ponds when the water in the raising-ponds has reached a temperature of 10 degrees C. or more; therefore, generally towards the end of April or the beginning of May. For wintering the spawning carp which are already selected when the other ponds are fished, special small winter-ponds are constructed,

which should be particularly well protected and have an abundant supply of water.

In the winter-ponds proper, but still more so in the ponds of older fish when used as winter-ponds, frogs and toads should not be allowed in any considerable number, because in early spring they cause the sickness and death of a large number of fish, by settling on their heads and placing their fore feet on the eyes of the fish, thus sometimes preventing them from taking food for weeks. Old carp-raisers who were well acquainted with such occurrences, thought that the frogs ate the eyes and brain of the carp, or sometimes used the carp as a horse, to carry them quickly to some good feeding-place where they would snatch the food from the mouth of the poor fish. These explanations are entirely erroneous. The male frogs and toads—and only such are found on carp—will often sit on the females for weeks before spawning, so as to impregnate the eggs the moment they are laid. The sexual desire of the male frog is so strong that he will not even let go of a dead female, and if no female can be found, he will even mount another male frog or any other object that comes in his way. The head of the carp, which during the spawning season of the frogs is still in a sort of torpor, appears to the frog as a very suitable object for his purpose, and when the ponds were drained in spring hundreds of carp, and sometimes even trout, were found with frogs firmly adhering to them.

Another most dangerous enemy to the fish in the winter-ponds is the otter, which, when a favorable opportunity presents itself, will kill more fish than it can devour, and which, if found in large numbers, may destroy the entire stock of fish. A constant watch should therefore be kept for any traces of this bitter enemy of the carp.

5. The stock-ponds.

The stock-ponds are small basins, frequently with brick or wooden walls, having an abundant supply of water, which serve for keeping those fish which are shortly to be sold. Their bottom should be of clay. If they have a sufficient supply of water, and if the fish are not to stay in them for any great length of time, they may be stocked at the rate of 50 kilograms carp per one square meter.

6. The pond-fisheries.

During summer—apart from the transplanting of young fry necessary in Dubisch's method—one should not fish in the carp-ponds with nets, because this disturbs the fish, most of which, moreover, either slip away under the net, or leap over it. Fish may, however, occasionally be caught, when they are needed, with fish-pots, or with hooks and lines, unless one should prefer to construct small stock-ponds for keeping the fish intended for home consumption. In such stock-ponds the fish must of course be fed, and can easily be taken with a small purse-net.

In the spawning-ponds, the raising-ponds, and the ponds for older fish the fisheries take place regularly late in autumn, and in the winter-ponds in spring. Cool weather is absolutely necessary, in order that the fish may not suffer, when crowded together in a very small sheet of water, or when entirely out of the water. Fishing at noon-time should, therefore, be avoided. The water should flow off gradually, so that, especially in large and shallow ponds with a luxuriant vegetation, the fish do not suddenly get on dry land, but have time to retire to the ditches, and ultimately to the fish-pit. The pond-farmer should, of course, know what time it will take each pond to be laid dry, and should arrange it so that fishing commences early in the morning. Before the autumn fisheries commence, the winter ponds and the ponds for older fish about to be stocked, and before the spring fisheries, the spawning-ponds and raising-ponds should be thoroughly put in order, so that the carp may be transferred to their new abode without delay. It often happens that old ponds of great size, especially when they contain springs, cannot be laid dry completely. Then all that can be done is to crowd the fish together in one place having a moderate depth of water, when it becomes necessary to employ small drag-nets, and sometimes even light boats. In small and well-constructed ponds, however, all the fish will gather in the fish-pit, whence they can easily be taken with purse-nets. When taken out of the water they are, if necessary, washed in tubs with clean water, and taken to the shore on wooden frames (see Plate V, Fig. 17), covered loosely with a net, which are carried by two men. When on shore they are numbered, weighed, and placed in the transporting vessels, which, as soon as they have received their full load, are at once shipped to their destination. All the fish should be treated very carefully, and be neither pressed nor thrown any distance. Sick and damaged fish should be eliminated at once. When the fisheries take place in the ponds for older fish, the more tender pike, perch, and perch-pike should be taken out before the carp, and placed in suitable receptacles. The spawning-carp for the following year should be selected with special care, and be kept separate. Tench and crucians are taken out after the carp, and any small perch-pike which may be found are placed in separate ponds as food for pike.

As in every well-regulated farming operation, so also in carp-culture, it is necessary to ascertain exactly the increase in weight of the carp, the losses, and the products of the different sheets of water. This is done by counting and weighing. Large fish are *counted* one by one, and the one summer's fish are measured in small dippers, whose capacity has been ascertained by counting the number of fish of two or three different sizes which such a dipper will hold. The *weighing* of large fish is done by means of scales, the one intended for the fish being made of wickerwork and capable of holding about a hundred pounds of fish. Smaller fish had better be weighed in small baskets capable of holding 10 to 20 kilograms, in order to prevent the fish from pressing upon each

other. If the size of a pond, the number and weight of the carp placed in it, and the number and weight of the carp caught in it are known, it will be easy to ascertain the yield of the pond per hectare.

Short distances, from one pond to the other, the carp can be transported in baskets or portable nets, and also in wagons, packed in moist straw. In this way they can be transported several hours. For greater distances they have to be put in barrels, having a capacity of 1 to 5 hectoliters. These barrels should be watered for a long time before being used; they must be quite smooth on the inside, and when intended to receive fish, be filled two-thirds with water. For journeys occupying several days, the fish have to be prepared, by keeping them in running water for several days, and not giving them any food, in order that they do not pollute the water in the barrels with their excrements. It is best not to put more than 150 to 200 pounds of fish in a barrel holding 5 hectoliters. The water should be partly renewed several times a day, and its temperature should not exceed 10° C.; if necessary, it should be cooled with ice. It is strongly to be recommended to introduce air direct by means of bellows to which a long rubber tube is attached. The bellows can be worked by hand, or by the turning of the wagon-wheels.

7. The cleaning and planting of the ponds.

As has been stated above, it is advisable to let the ponds lie dry during winter, in order to destroy the vermin. In most ponds mud will gradually accumulate, partly brought from the surrounding heights by the rainwater, and partly formed by decaying vegetable matter. On the edges of the pond mud becomes valuable, because it offers food for numerous small animals, but in the depths it becomes hurtful, because it is stirred by the violent motions of the fish and makes the water turbid. When the ponds are laid dry it should therefore be carted away once a year, or at longer intervals; and when piled up in heaps it has been allowed to dry, it can generally be used as a fertilizer for meadows and fields.

By the planting of ponds we understand their use for cultivating grass, clover, oats, &c., for a period of one to two years after they have served the purpose of fish-culture for three to six years. The advantages of this system of rotation have been known for centuries, and consist in this, that by plowing, and by roots of plants entering the bottom of the pond, it is loosened, and from the roots and stubble receives many substances, which are dissolved in the water, and serve as food for fish directly or indirectly. The mud which has accumulated in the pond during the period of fish-culture is moreover extremely fertile, and will need no manure in order to produce a rich crop. The ponds are generally sowed with timothy grass, clover, or oats, which yield a rich harvest. In some places it is customary to plant the ponds with turnips, and to fill the pond with water in autumn, without taking them out.

Especially in ponds which are not traversed by a brook or river this is a dangerous practice, as the water can easily be polluted thereby; under all circumstances such a pond should not be stocked till the following spring.

8. The feeding of carp.

The growth of fish depends on the quantity of food to a much higher degree than that of our domestic animals. In order, therefore, to obtain satisfactory results in fish-culture, it is of the utmost importance to give the fish an ample quantity of food. In the first place the ponds should not be overstocked, and should be made to produce more fish-food, by planting them from time to time. Many attempts have been made to artificially increase the small animals which serve as fish-food. Infusoria, diminutive crustaceans, and larvæ of different insects will develop in greater quantities in shallow, calm, and warm water than in deep water; and it is therefore an advantage if the edges of the ponds are shallow. Occasionally small pits are dug near the banks, and connected with the pond by a narrow ditch. In these pits it is sought to produce the conditions which attract insects about to deposit their eggs, and which favor the development of these insects. Strongly diluted manure water is a favorite place for gnats to deposit their eggs, and the pits will soon swarm with larvæ, large numbers of which will reach the pond by means of the narrow ditch. If this process can be aided by letting a small stream of water flow through the pit into the pond, it is all the better. For filling these pits Stenzel recommends the leaves of the alder, poplar, and beech. It is very desirable that systematic experiments should be made relative to this manner of increasing insects, &c., which form an excellent fish-food, especially for young fish. The spawn of frogs forms an excellent food for fish, as also young tadpoles. It may also be recommended to place above the surface of the water a number of boxes with wire bottom, containing moderately sized pieces of meat, which are soon covered with the larvæ of the blow-fly. As soon as these larvæ have became large and heavy, they fall into the water in great numbers and form a welcome food for the fish.

From times immemorial, attempts have been made to fatten carp by giving them artificial food, and a number of vegetable and animal substances are suitable for this purpose. Only such substances, however, should be employed which can be obtained cheaply, and which bear in themselves the guarantee that the capital invested will bear rich interest. Systematic experiments as to the comparative nutritiousness of the different substances mentioned in this connection have not yet been made anywhere, although they would be of great value to carp-culturists. Scientific institutions are generally not prepared to make such experiments, as but very few of them have any ponds at their disposal; and fish-culturists who of late years have often sought advice from nat-

uralists have not yet deigned to make such exceedingly simple experiments which are of the greatest importance to them. Nothing is needed for such experiments but a number of ponds of the same character, whose size is known. These ponds should be stocked with the same carefully ascertained weight of carp of equal size per are; in one of these ponds no food should be given to the carp, and in the other ponds different articles of artificial food, whose price is well known, should be fed to the fish, in even quantities; and during the autumn fisheries the increase of weight per are should be calculated for every pond.

For the time being we do not feel justified in recommending any particular food, and can only mention the kinds most commonly in use; and any one may from this list select those which he can obtain cheapest. The food is thrown into the water near the edges of the pond either by itself or kneaded together with clay, and it will soon be seen whether the fish take to a food or not. This is of special importance in ponds through which flows no river or brook, as food which is not consumed by the fish would decay in them and pollute the water. Some people recommend the dung of cattle, sheep, and hogs, also fine flour, bran, husks, maltsprouts, boiled lentils, beans, lupines, peas, potatoes, turnips, the solid refuse from distilleries, the remnants of beets from sugar-refineries, the refuse from dairies, boiled blood, &c. It may be well to mix a number of these articles and knead them with clay. In some places some of the articles of food mentioned above, mixed with clay, are made into flat loaves, which are dried either in an oven or in the sun, and can then be kept for a long time. Occasionally snails, cockchafers, and worms—wherever they can easily be obtained in large quantities—may be mixed with this food. It is not advisable to throw into the ponds the flesh of worthless animals; it is especially to be avoided to have entire dogs, sheep, or quarters of beef or horses thrown into the pond, as is done in some places, because the water easily becomes polluted thereby, and because the fish cannot bite off pieces. They can only eat such articles of food as they can take into their mouths and devour at once. They always like meat chopped fine, especially if it is mixed with flour.

Recently various articles of food mixed on scientific principles have been recommended, and it is very desirable that they should be subjected to a systematic examination; wherever a systematic method of feeding will quickly, and without any great outlay, increase the yield of ponds, it is of course to be recommended.

9. THE RELATIVE SIZE OF THE PONDS.

As in agriculture, so in pond-culture, a rational use of a given area only becomes possible, if based on a proper system. It is of special importance to maintain the proper proportion in the relative size of the spawning-ponds, the raising-ponds, and the ponds for older fish. If

there is not a sufficient area of raising-ponds for the fish produced in the spawning-ponds, the ponds will be overstocked, there will be consequently a lack of food, and the fish will not grow as well as in ponds which are not so crowded, and where they find ample food. The pond-farmer will have to ascertain by experiments the productivity of his different ponds, and should know what quantity of fish every are of his ponds can produce, under normal circumstances. It is, therefore, absolutely necessary to have a thorough system of books, recording every fact relative to the ponds. In the method generally employed it has been found that the following distribution of a given pond area is best suited for the purpose: 4 per cent. should be taken for spawning-ponds, 12 per cent. for raising-ponds of the first class, 18 per cent. for raising-ponds of the second class, 60 per cent. for ponds for older fish, and 6 per cent. for winter-ponds. The matter is entirely different if Dubisch's method is followed, when a much larger quantity of young fish are raised. In that case one should count to a 0.1 hectare spawning-pond, 3 hectares raising-ponds of the first class, 71 hectares raising-ponds of the second class, and for the fish obtained during the first year (one summer's fish) in the following year 137 hectares raising-ponds, and during the third year 333 hectares raising-ponds. To correspond with these ponds, the number of winter-ponds should also be gradually increased.

10. The different races of carp.

Among the common carp, which have regular scales, there are occasionally found, both in ponds and in open waters, fish which have either no scales (leather carp) or only a few very large scales, which generally extend in a row on each side from head to tail (mirror carp). Both these varieties are specially raised in some places, and are considered to grow faster and have a more delicate flavor than the ordinary carp; but no comparative experiments have been made relative to this question, and all the conditions being equal, there will be but little difference between these varieties. If the people in some locality show a special liking for one or the other of these varieties, pond-farmers will of course have some regard to it. Young fry and spawning fish of the different varieties can easily be obtained in many places.

Of late years the so-called "blue carp" has become a great favorite. This fish comes originally from Bavaria; when out of the water its color is a grayish blue, and in the water a beautiful dark blue, whilst as a general rule the back of the carp has a darkish-brown, and its side a leather or bronze color. It is said that the blue carp needs warmer water than other carp, spawns later in the season, and when it has reached a more advanced age is quieter and more inclined to seek its food. Among the blue carp there are also found leather and mirror carp. On the whole the blue carp are still confined to a few localities,

and it remains to be seen whether they will everywhere retain their much talked of excellence.

11. The yield of the carp-ponds.

The question whether carp-raising will pay is of course of great importance to landed proprietors. It has often been said that a carp-pond will yield more revenue than the same area planted with wheat. This assertion does not seem to be borne out by the fact that, in many places where formerly there were numerous carp-ponds, they have been laid dry and abandoned in course of time. In the north of Germany and many parts of Central Germany this circumstance is easily explained by Luther's Reformation, and the very imperfect means of communication in those days. The abolition of the numerous fast days observed in the Roman Catholic Church, which necessitated the maintenance of regular and extensive pond-farms in connection with the convents, greately diminished the demand for fish, and as matters stood in those days, the transportation of fish to any considerable distance was not thought of. Under these circumstances it was of course more profitable to drain the ponds and use them for agricultural purposes. To-day all this is changed; on the one hand the price of grain has been lowered by foreign competition, and on the other hand our improved means of communication make it possible to send all those fish which are not needed or home consumption to other places, and thus derive some profit therefrom.

In judging of the revenue to be obtained from carp-culture, it should be taken into consideration that it requires less labor than agriculture, and is much less dependent on changes of the weather.

The production of fish of course depends on the quality of the ponds, and it would be a mistake to compare worthless ponds with good fields, and good ponds with poor fields. Unfortunately it is hardly possible to give exact data as to the average quantity of fish-flesh produced per are or acre, by good, medium, and poor ponds. An exact system of book-keeping, which is necessary for this purpose, may be in force on large pond farms whose pond area amounts to hundreds and thousands of hectares, but it is rarely found on small farms, whose proprietors often do not know the size of their ponds, nor the cost of labor, nor the weight and number of the fish placed in the ponds and taken out during the fisheries. C. Nicklas, in his admirable Manual of Pond-culture (Stettin, 1880), gives very valuable hints how to keep the books of a pond farm.

It is generally presumed that good carp-ponds, if properly managed, produce annually 70 to 90 kilograms of carp-flesh per hectare; and in following Dubisch's method the yield would be 130 kilograms per hectare. In poor ponds the yield is of course much smaller. On an average the kilogram of carp-flesh when sold to dealers will realize 1 mark (23.8 cents), whilst when sold at retail the same quantity will frequently fetch

1.50 marks to 2 marks (35.7 cents to 47.6 cents). One summer's and two summers' fish, when sold to pond-farmers, will often fetch even better prices.

It should, however, also be taken into consideration that by stocking lakes with carp of suitable size, which owing to their large number find no room in the ponds, the revenue from the lakes may be materially increased. Some account should also be taken of the income from the grass growing along the edges of the ponds, from the mud, from the willows on the dikes, and in large ponds from the reeds. Wherever the ponds are numerous some of them will be planted every year and will yield a rich harvest of hay or oats without any outlay for fertilizers. It may therefore be considered as a matter beyond doubt, that wherever the conditions are favorable for carp-culture, it should be urgently recommended as a most profitable industry.

V.—CULTIVATION OF OTHER FISH.

In ponds adapted to carp-culture, other fish, of kinds resembling the carp, may be raised. As they are generally of less value than carp, only inferior ponds will be used for this purpose.

The tench (*Tinca vulgaris* Cuv.) is in some localities esteemed as highly as the carp. It is extremely prolific, loves calm, muddy waters, and principally lives on food which it roots up from the ground. Wherever it occupies a pond with carp, it will not diminish the carp-food, and may therefore safely be kept in limited number in raising-ponds of the second class and in growing-ponds (ponds for older fish). They may be allowed to spawn in separate small spawning-ponds, and their young fry may be profitably used for stocking shallow and muddy lakes, having a good deal of vegetation, in which they will grow rapidly, frequently reaching a length of 50 centimeters, and a weight of 2 to 3 kilograms. To raise tench in special raising-ponds, is hardly to be recommended.

The crucian (*Carassius vulgaris* Nils.) is, when it reaches a good size, a fine fish, which is highly esteemed by many people. It is exceedingly frugal in its tastes, will flourish in the most turbid water, and even in small puddles multiplies so rapidly, that the fish, from want of food, do not grow much longer than a finger. For utilizing muddy puddles, small ponds in court-yards, marl-pits, &c., the crucian may be highly recommended. By frequent fishing, the survivors reach a considerable size, and the little fish which are taken out can be placed in muddy lakes, and branches of rivers, where they will grow rapidly. In some places it is customary in spring to place a few small pike in the puddles swarming with crucians. By feeding on these the pike grow with extraordinary rapidity, and their flesh becomes particularly tender and of an excellent flavor. In autumn the pike should be caught, as during winter they would suffocate under the ice. By the side of them the thoroughly decimated crucians grow rapidly. Wherever there is a lively

demand for large crucians, they may be placed in growing-ponds with carp; but the young carp fry found during the fisheries can, even more than otherwise, be only used for feeding fish of prey, or for stocking rivers and lakes, as apart from their small size they are mostly worthless bastards of crucians.

The goldfish, a gold-colored variety of the crucian, can be raised in small, warm ponds, without much trouble, entirely on the same plan as carp are raised. If there is a steady demand for one summer's and two summers' fish the culture of goldfish may, under certain circumstances, prove very profitable.

The golden ide (*Idus melanotus* Heck. & Kner., var. *miniatus*) is but of little importance as a food-fish, but is highly esteemed as an ornament for garden and park ponds, as it resembles the goldfish very much in its color, and reaches a length of 40 to 50 centimeters. These fish will stay near the surface in large numbers, but are so sly and quick that it is not easy to catch them. Persons who desire to raise these fish on a large scale will have to follow the rules laid down for raising carp. This can only be recommended, however, in localities where there is a certain sale, at a good price, of large numbers of young fry.

The bleak (*Leuciscus rutilus* L.), the red bream (*Scardinius erythrophthalmus* L.), and the "*Uckelei*" (*Alburnus lucidus* Heck.) can be raised in many places to considerable advantage as food for fish of prey. All these fish are satisfied with small, shallow ponds, and increase very rapidly. As the object is only to raise an enormous number of young fry, which are caught when quite young and fed to other fish, it is not necessary to construct raising-ponds and growing-ponds; on the other hand the ponds destined for these fish must offer the most favorable conditions for depositing spawn, and for the development of the young fry. The ponds should be shallow, so that they can be quickly heated, and it is advisable to construct so-called "spawn-beds," such as are sometimes used in carp-ponds. These "spawn-beds" are raised places on the bottom of the pond, resembling garden-beds, which are laid out in rows at suitable intervals, and whose surface is planted with grass, water-cresses, and other plants which grow well in moist meadows, or are covered with sod taken from such meadows. These beds should be 10 to 20 centimeters below the surface of the water. The fish take a particular delight in spawning in these places; the eggs, adhering to the grass and the plants, develop very rapidly in the shallow water, and the young fry finds welcome hiding-places and ample food among the plants. The fish can easily protect themselves against strong heat by retiring to the deep ditches between the beds. Such ponds furnish an almost inexhaustible supply of food for trout-ponds, and the beauty of it is that the food-fish grow at the same rate as the fish to which they are fed.

The bream (*Abramis brama* L.) is one of the most valuable fish for large and deep lakes. It reaches a length of 50 to 70 centimeters, and

a weight of 10 to 15 pounds and more, and enormous quantities are caught, especially in winter, under the ice.

This fish is less adapted for raising in ponds, but it is well to let it spawn in good ponds, provided with spawning beds; and when the young fry (which have been produced in enormous numbers) are several weeks or months old, they can be transferred to lakes. The simplest plan is to construct the spawning-ponds close to the lakes and connect them by small ditches, and have grates in these to prevent fish-of-prey from entering the lakes.

VI.—THE RAISING OF LOACH AND GUDGEONS.

The loach (*Cobitis barbatula* L.) is one of our finest fish, which seldom reaches a length of more than 15 centimeters, but is highly esteemed in many places. In small ponds with sandy and gravelly bottom, or where a river or brook flows through it, these fish can easily be kept, and increase rapidly. The best way is to construct loach-ponds in brooks by gathering the water in some suitable place, and inclose a portion of the brook by fences of wicker-work. The fish thus remain in their natural surroundings, and if fed with the same food as the carp, grow very rapidly. It is quite common to place in the ponds baskets filled with sheep-dung. The best way to catch loach is to use small fish-pots of narrow wicker-work, in which husks, boiled potatoes, boiled blood, cheese, &c., are placed as bait.

In a similar way the gudgeon (*Gobio fluviatilis* Cuv.) can be kept Although very small, it forms a savory dish when baked.

As both these kinds of fish increase enormously, it will be well to construct several small ponds, so that from time to time those which are over-crowded may have some of their fish transferred to other ponds.

VII.—THE RAISING OF FISH-OF-PREY SPAWNING IN SUMMER.

The raising and keeping of fish-of-prey spawning in summer is much less common than that of the carp and other fish of the same family, for the simple reason that it is much more difficult to provide the necessary food. The only fish which can be mentioned in this connection are the pike, the perch, and the perch-pike.

The pike (*Esox lucius* L.) is a most voracious fish-of-prey; and its raising can only be profitable where there is an unlimited supply of worthless food-fish, and where pike fetch a good price in the market. In most cases it will be best to place young pike in raising-ponds and growing-ponds for carp, or in ponds for crucians, in which they grow rapidly, and also propagate, and from which they can easily be removed before they have grown too large. Water containing many frogs is particularly well suited for keeping pike, as frogs form the favorite food of this fish.

The perch (*Perca fluviatilis* L.) is an excellent food-fish, but is hardly ever raised in ponds by itself, but generally in raising-ponds and growing-ponds for carp, and in ponds for crucians, in which it grows rapidly and increases enormously. As, besides small fish, its favorite food is worms and insects (the same food which the carp likes), it should not be placed in carp-ponds in too large numbers, unless it fetches a higher price in the market than carp.

The perch-pike (*Lucioperca sandra* Cuv.) is esteemed higher and fetches a better price in most places than the perch; it feeds on the same kind of food, and is frequently kept in large and deep growing-ponds for carp. It loves deep, cool, and pure water, and a hard, sandy or gravelly bottom; and in such ponds it will increase very much, especially if suitable spawning-places are provided. For this purpose it may be recommended to put stumps of trees with branching roots near the banks, or to construct in various parts of the pond cone-shaped piles of stones and gravel, measuring about 1 meter in height. In shallow ponds with a soft bottom the perch-pike will also grow, provided there is an ample supply of food, but they will not increase. For stocking deep lakes with a hard bottom, the fry of the perch-pike is well suited.

VIII.—KEEPING EELS IN PONDS.

It is well known that eels only propagate in the sea, where the male fish stay all the time, whilst the young fry in spring or early summer, when measuring only a few centimeters in length, ascend all fresh waters in enormous numbers, work their way over weirs and rocks, in order to reach the upper course of the rivers, and the lakes situated near them, and are at that time without sexual distinction, but without exception develop into females. These, in order to propagate the species, have to return to the sea, and on these migrations, which are undertaken during the summer and autumn months, the great eel-fisheries in most of our rivers depend. Under no circumstances can an increase of eels in fresh water be counted on; but it is possible to facilitate their journey up the rivers by constructing eel-ways, and also to introduce them into waters which without human aid would always remain closed to them.

From time immemorial the ascent (*montée*) of the young eels up the rivers, which takes place in France every year in exceptionally large proportions, is used for collecting large numbers of the small fish, which are sent considerable distances, packed in moist grass, and used for stocking ponds, marl-pits, and peat-bogs. Also in Germany large quantities of young eel-fry, from France and Italy, have for a number of years been successfully planted in ponds and lakes. When these fish arrive in May, they are about 6 or 8 centimeters long and 2 or 3 millimeters thick, and about 1,000 of them make a pound; but in autumn of the same year they have generally reached a length of 20 to 25 centimeters, and the

thickness of a small finger; in the following autumn they reached a length of 50 to 60 centimeters; and their growth may therefore truly be termed very rapid. According to information furnished by the well-known French fish-culturist, Millet, 1 kilogram of young eels placed in an extensive peat-bog near the river Aisne, in 1840, had increased so rapidly that five years later 2,500 kilograms of large eels were caught. For stocking small ponds with a soft bottom, marl-pits, and peat-bogs, and also large lakes, the young fry of the eel can be highly recommended.

Nets cannot be used for catching eels, because they generally root deep in the ground; they are, therefore, only discovered after the pond has been laid dry, by drawing a rake through the mud. They are easily caught, however, with fish-pots, purse-nets, and with a hook and line.

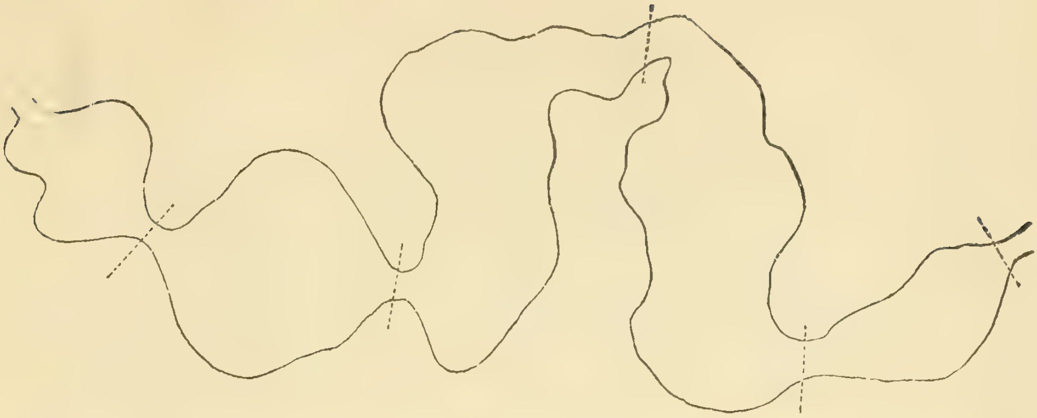


FIG. 1.—Valley, to be transformed into ponds by means of dikes.

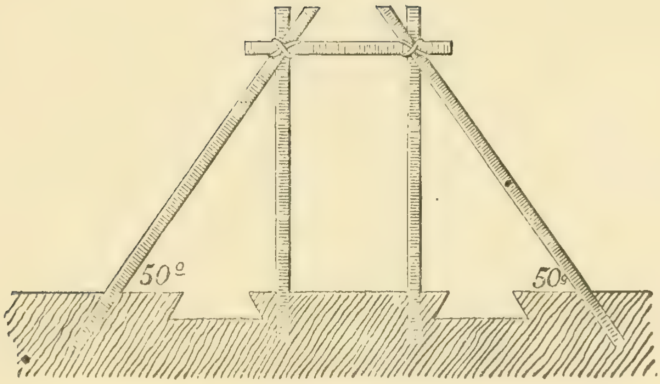


FIG. 2.—Staking out the dike.

FIG. 3.—Position of the pieces of sod.

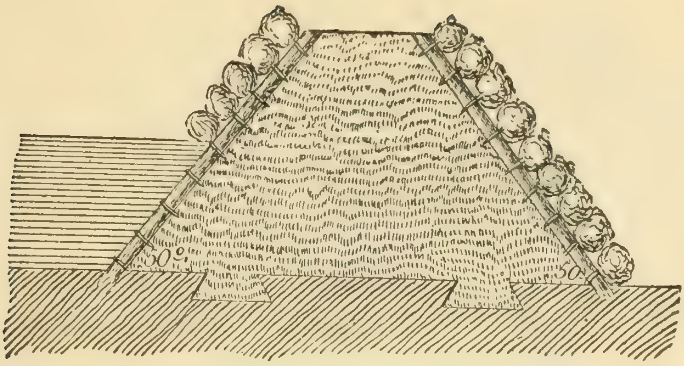


FIG. 4.—Section of dike.

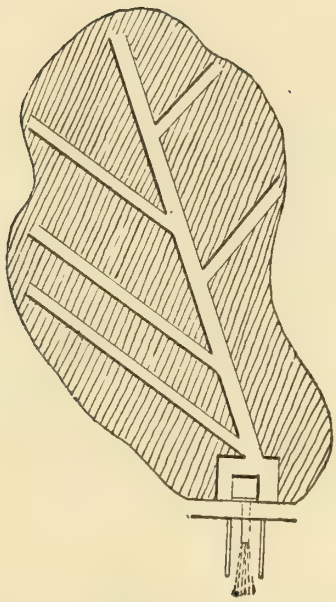


FIG. 5.—Fish-pit and ditches.

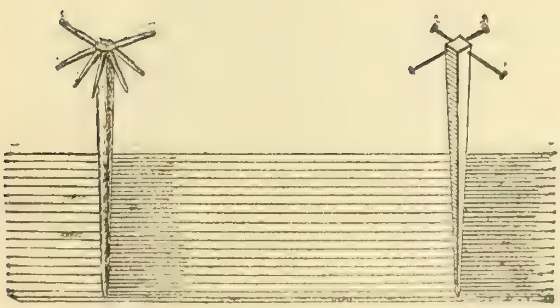


FIG. 6.—Protection posts against thieves.

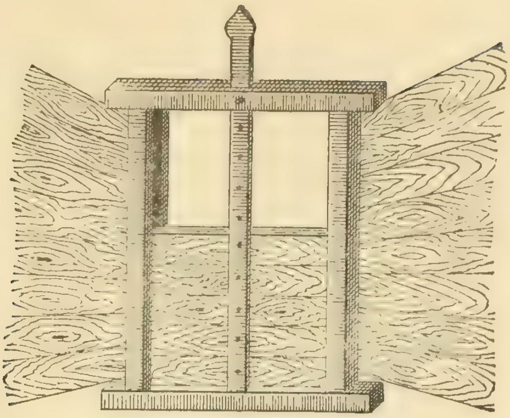


FIG. 7.—Sluice.

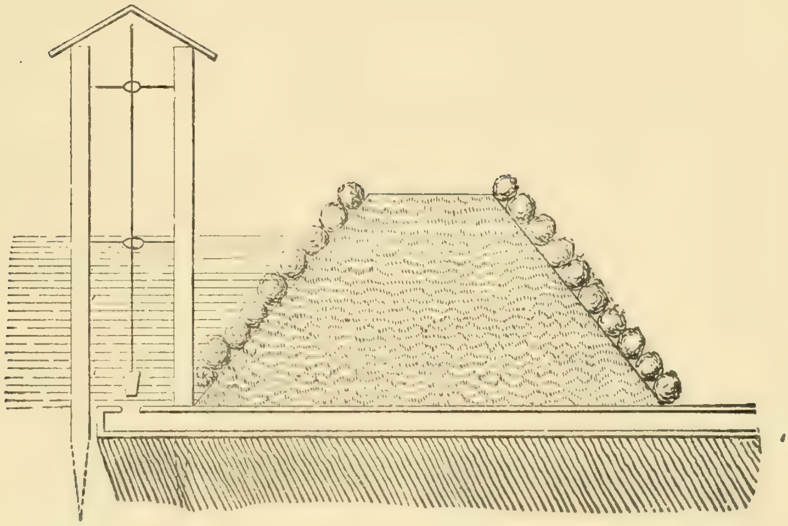


FIG. 8.—Tap-outflow.

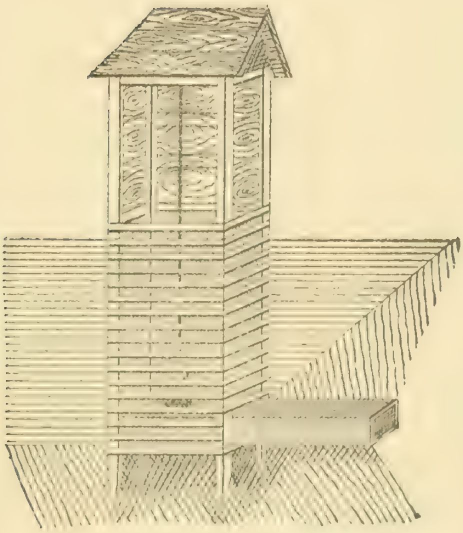


FIG. 9.—The tap-house.

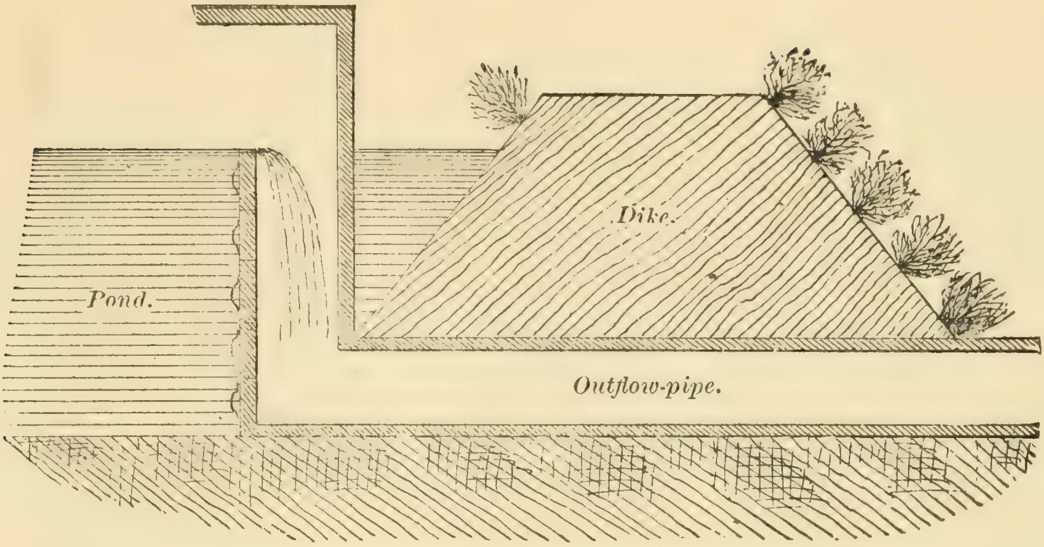


FIG. 10.—Section of a "monk."

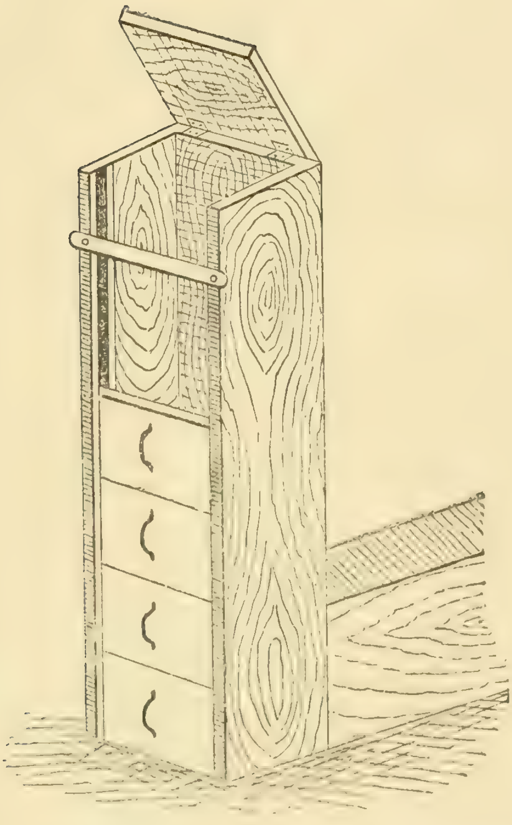
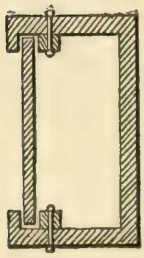
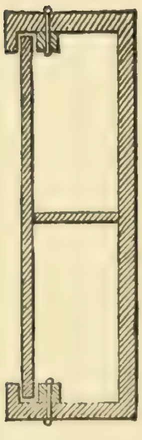
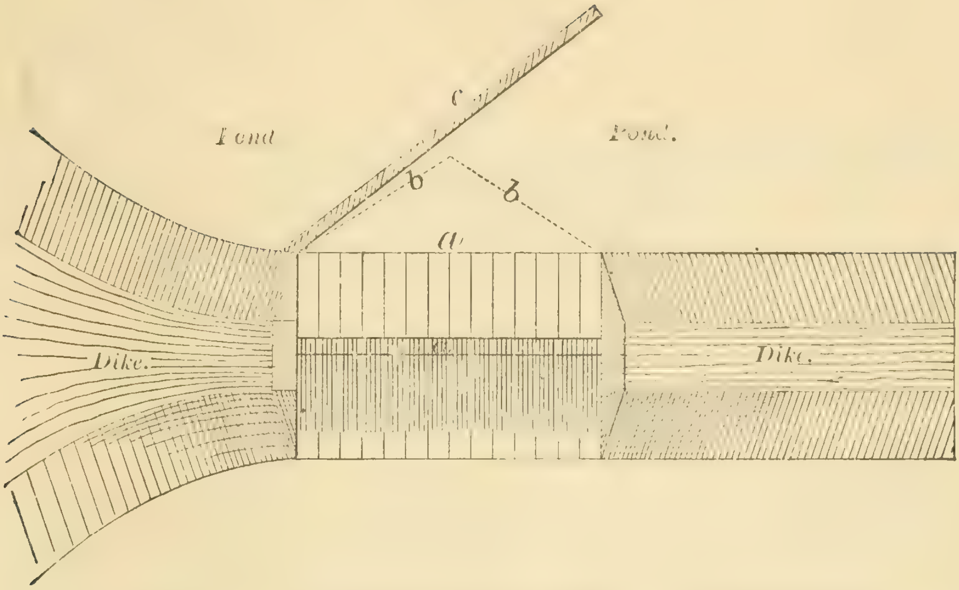


FIG. 11.—Perspective view of a "monk."





FIGS. 12 and 13.—Transverse section of the perpendicular pipe of a narrow and broad "monk."



a Grating. *b.* Position of angular grate. *c.* Floating beam.

FIG. 14.—Dike with weir, grating and floating beam, viewed from above

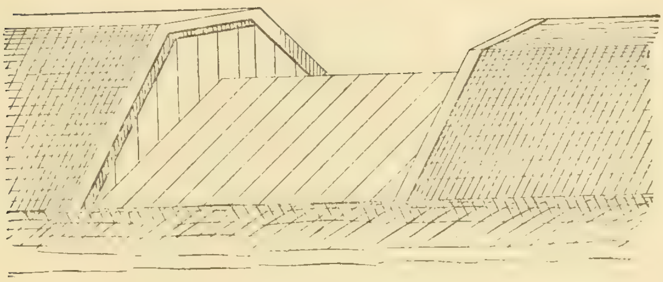


FIG. 15.—Weir.

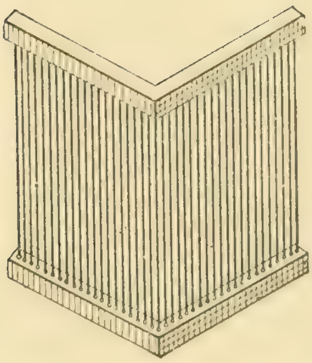


FIG. 16.—Angular grate.

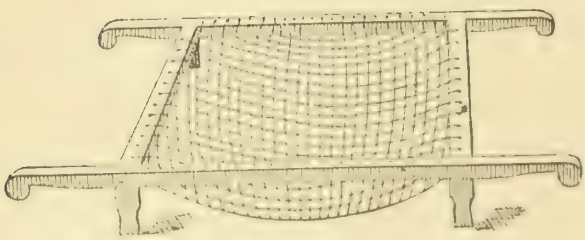


FIG. 17.—Portable net for carrying carp.

XXXVI.—HOW TO RAISE CARP AND OTHER POND FISH WHICH SPAWN IN SUMMER.*

By Max von dem Borne.

In artificial fish-culture we possess a very efficient means of improving our fisheries; but the much older method of fish-culture in ponds has not been rendered superfluous thereby. By artificial fish-culture we understand the artificial impregnation of fish-eggs by extracting the spawn from fish and mixing the eggs with milt and water, and also the batching of these impregnated eggs in hatching-boxes. Fish-culture in ponds, which, even in the Middle Ages, had reached a high degree of perfection on estates belonging to monasteries, leaves the propagation to the fish themselves. The different kinds of fish may be classified as they are suited for artificial fish-culture or for being raised in raising-ponds.

I. *Artificial fish-culture.*—The following are adapted to artificial fish-culture: The salmonoids (the salmon, the different kinds of trout, the salbling (*Salmo salvelinus*), grayling, the different varieties of the *Coregonus*), the may-fish, pike, sturgeon, and different kinds of salt-water fish.

II. *Pond culture.*—The following are adapted to pond culture: (*a*) On soft bottom: The varieties of *Cyprinus* (carp, crucian, tench, bleak, ide, goldfish, &c.), river-perch, *Silurus*, pike, &c. (*b*) On sandy, gravelly, stony bottom: The perch-pike, the American black perch, &c.

Herr von Behr, of Schmoldow, president of the German Fishery Association, has requested me to describe in a few pages and in as simple a manner as possible, how fish-culture in ponds, apart from a well-regulated carp culture, can be raised to much greater importance than it possesses at present. I gladly comply with this request by endeavoring to describe how fish which spawn in summer can be raised in ponds.

We aim at introducing again into our rivers, where the old spawning places have been destroyed by the different river improvements, large masses of the fry of carp, bleak, tench, crucians, perch, perch-pike, &c. We also aim at making small ponds, marl-pits, and peat-bogs sources of income by stocking them with fry. I shall, therefore, attempt to show how young fry for these purposes can easily and cheaply be procured at home, instead of getting it from abroad at a comparatively heavy

* *Züchtet Sommerlaichfische.* Translated from the German by Herman Jacobson.

expense. How often does a ditch with running water or a little brook offer an opportunity to transform a hitherto dry area into a pond, and many of our large estates have watercourses which are admirably adapted to this purpose.

On the estates of Archduke Albrecht, near Teschen and Saybusch, Thomas Dubisch, inspector of fisheries, has introduced into carp-pond culture a method invented by himself, by which the production of carp fry is secured, and by which the yield of the ponds has been considerably increased. I will here state what I learned during a visit to these estates. The archducal farmer, Adolf Gasch, of Kaniow, informed me that he had made an improvement on the method of Dubisch; but as it was a professional secret, I am unable to judge of it. I am under great obligations to the director of the archducal farms, Mr. Walcher-Uysdal, at Teschen, for his friendly assistance. The carp-raising pond which Dubisch uses is also adapted to the raising of bleak, tench, crucians, perch, and other fish, which spawn on a soft bottom. The pond need not be larger than 0.1 hectare [$\frac{1}{4}$ acre]; and a depth of from 0.3 to 1 meter [12 to 39 inches] is quite sufficient. When the water is to be let off, the bottom water should be brought down to at least one-third meter [13 inches] below the bottom of the pond, so that it can dry out completely; it is therefore crossed by a number of ditches of sufficient depth, whereby all injurious animals, such as frogs, beetles, larvæ, &c., are removed and the acids are withdrawn from the bottom. A soft bottom of clay, peat, or sand, and the possibility of laying the pond entirely dry, are essential conditions of success. The pond lies dry during winter and spring, and is filled with water only a short time before the spawning fish are placed in it. In order to keep strange fish away from the pond, Dubisch leads the water which feeds the pond through a gravel grate, which completely answers the purpose. With laths a box is constructed, measuring 6 to 8 meters [20 to 26$\frac{1}{2}$ feet] in length, which is filled with sifted gravel, varying in size from a hazel-nut to a hen's egg. When too much mud accumulates it is removed by shoveling. A set of spawning carp comprises one spawner and two small milters. Young carp generally spawn more vigorously than old ones; but Dubisch is certain that he has also obtained offspring from spawners weighing 15 pounds. The spawning carp and the young carp are during winter kept in a winter-pond, and in spring are placed in a wooden or walled tank, where they do not eat anything and have no desire for spawning. It is best to keep fish of different sexes separately.

The spawning pond is generally stocked during the second half of May. The carp may be used still later, however, as they do not spawn in the tank. A temperature of the water of more than + 14° R. [63$\frac{1}{2}$° F.] is so essential for spawning that the water should be raised to that temperature by artificial means. In this manner Christian Wagner, at Oldenburg, the well-known breeder of goldfish, has caused his carp to spawn as early as March. As a general rule the fish will spawn as

soon as they are placed in the pond, provided that the temperature of the water is at least 14° R. If this is not the case after a few days, and if the water begins to be turbid, the fish may not spawn at all. If the same fish, however, are placed in another spawning pond which has just been filled, they will, as a rule, spawn at once. It is necessary to have several spawning ponds and a reserve of several sets of spawning carp, although they may be used only on rare occasions.

After a few days the pond swarms with small carp. Dubisch thinks that a spawner weighing 7 or 8 pounds produces 100,000, and one weighing 12 to 15 pounds produces 200,000 young ones. These are amply sufficient for a farm having a pond area of 500 hectares [1,236 acres]. For spawning carp the largest and best-formed fish are carefully selected from fish of the same age, because rapid growth is hereditary among fish. It is important that the young fish should grow as large as possible during the first summer. It is therefore necessary that the carp should spawn as early in the season as possible.

RAISING-PONDS.—As the little fish grow larger their demand for food increases. Large fish, therefore, need a greater water area than small fish in order to obtain sufficient food. Only when there is at no time any lack of food will the fish develop in a favorable manner, and will put the food which is supplied to the best possible use. After the young fish have consumed the umbilical sac they commence to seek food, and the pond soon becomes too small for them. If care is not taken to supply more food, the numerous fry will disappear almost entirely in a few days, dying from hunger. About five days after the fish have been hatched they are taken out of the spawning pond and are placed in raising-pond No. 1, so that, according to estimate, 100,000 young fish get 3 hectares [7½ acres] of pond area.

The fishing of the fry is done in the following manner: The water of the pond is either let off slowly through a fine wire grate (6 wires to 1 centimeter) [15 wires to 1 inch] while fishing is going on at the same time, or the water is not let off, and the fry are caught with a gauze dipper measuring 0.5 meter [20 inches] in diameter. To receive the fry temporarily Dubisch uses a large seine floating in the pond with a high wooden edge, and a bottom of exceedingly fine wire grating. Thence the fry are dipped out with a smaller gauze dipper, measuring about 0.2 meter [8 inches] in diameter and placed in a spacious tin vessel, taking out as near as possible by estimate 1,000 at a time. From the tin vessel they get into the transporting can. This can has a double bottom, the upper one of wire grating, the lower end of a tin tube opening between the two bottoms, and its upper end a few centimeters above the lower edge of the transporting can. When water is poured in the can it flows off through the tube, and carrys away dirt and excrements which may have accumulated underneath the wire bottom. Mr. Mühlbach, a tinsmith of Neudamm, sells such cans at 13 marks [$3.09] apiece. The raising-pond No. 1 has lain dry as long as possible, so that it may be

free from enemies of the fish and contain sufficient food. In about four weeks the young fish have reached the length of several centimeters, and are transplanted once more, because they can no longer find sufficient food in a pond having an area of 3 hectares [7½ acres]. So far about 25 per cent have been lost, so that only 75,000 young fish are taken out.

The raising-pond No. 2 has likewise lain dry as long as possible. It had been sown with grass or clover, which has been harvested. The pond is stocked at the rate of 1,050 fish per hectare [2½ acres], of which number, as a general rule, 1,000 are caught again in autumn, when they have reached the weight of one-quarter of a pound and more. If the pond is only stocked at the rate of 300 or 500 fish per hectare, carp weighing 1 pound may be obtained during the first summer.

The raising-pond No. 3 is stocked with carp of one summer, counting 520 fish per hectare [2½ acres]; and if fish of prey are kept out by means of a gravel grating, one will in autumn get of this number 500 carp of two summers, weighing from 1 to 1½ pounds and rarely 2 pounds (but not the latter unless the number of carp per hectare has been less than 520).

The stock pond Dubisch stocks with 206 carp of two summers per hectare, and gets in autumn 200 carp less than two and one-half years old, weighing from 2 to 4 pounds.

From the above we gain the following relative size of the different classes of ponds. This relative size will, of course, be changed if there is a change in the number of fish with which the ponds are stocked, in the losses and in the growth of the fish, or if some of the fish are sold before they have reached the age of two or two and one-half years. In making the calculation the average weight of 2.2 pounds per fish has been made the basis. This weight had in 1883 been reached by the carp on the estate of Perstetz, near Teschen, where pond farming had been carried on according to the method described above.

Ponds.	Size of ponds.		Number of fish placed in ponds.		Loss.		Yield.	
	Hectares.	Percentage of the total area.	Per hectare.	Per pond.	Per hectare.	Per pond.	Per hectare.	Per pond.
Spawning pond	0.1	0.018	....	3	....	....	....	100,000
Raising-pond No. 1	3.0	0.551	33,333	100,000	8,333	25,000	25,000	75,000
Raising-pond No. 2	71.4	13.111	1,050	75,000	50	3,570	1,000	71,430
Raising-pond No. 3	137.1	25.175	520	71,430	20	2,742	500	68,688
Stock pond	333.0	61.145	206	68,688	6	1,998	200	66,690

A total pond area of 544.6 hectares therefore yields annually 66,690 carp, at 2.2 pounds, or 146,718 pounds, *i. e.*, 269.4 pounds per hectare.

ECKARDT'S METHOD OF OBTAINING EMBRYONATED CARP EGGS.—A spawning pond of 0.1 hectare [one-fourth acre] is stocked with

about 60 spawning carp, and the edges of the pond are covered with juniper brush. Spawning proceeds on a gigantic scale, and the brush is soon entirely covered with spawn. As soon as the eye-dots become visible in the eggs, which, according to the temperature of the water, takes place in from two to six days, the brush with the spawn is packed like other embryonated fish-eggs and sent to considerable distances. Even after a journey of two days a great many young fish have been hatched from such eggs. The fish are hatched after from three to twelve days, and the pond swarms with innumerable little carp, whose further development is intrusted to the care of the pond cultivator.

For feeding carp and the fry of carp there are recommended ground meat, kitchen refuse [slops], and the excrements of hogs and sheep. In using artificial food care should be exercised, as the experience of our most prominent pond cultivators has so far not been very satisfactory, either as regards the feeding of fry or of older carp.

Raising perch-pike in ponds.—Mr. Reuter, superintendent of forests at Siehdichum, district of Guben, has been very successful in establishing artificial spawning places in lakes in which perch-pike had hitherto not propagated. I, as well as Al. von Gostkowski, in Galicia, have in the same manner raised perch-pike in ponds. A full description of Gostkowski's establishment has been given by Professor Nowicki, of Cracow, in the circulars of the German Fishery Association for 1883 [pp. 9–12 and 20]. The Galician pond has an area of 13 hectares [32 acres], and mine one of 11.5 hectares [28½ acres]. At a depth of 1 meter [39.37 inches] and more, places of considerable extent are covered with coarse gravel and stones, and here and there some heaps of stones are piled up. Near to these there are placed tree tops having many branches, which are cut just above the surface of the water. The gravel is cleaned every year, and the pond is allowed to lie dry as long as possible. In 1882 Gostkowski stocked his pond with 9 perch-pike and a number of small fish as food for the perch-pike, and in autumn he caught 120,000 young perch-pike measuring from 5 to 10 centimeters [2 to 4 inches] in length; but many of the fish had no doubt escaped from the pond before he could catch them.

At Wittingau perch-pike have often spawned in deep tanks which constantly had a good supply of water. It may, therefore, be presumed that they will do the same in small ponds, if these are sufficiently deep, are naturally or by artifical means, as described above, adapted to spawning, and contain suitable food for the perch-pike. In ponds arranged in this manner the American black perch can also be raised.

Stocking of lakes and rivers with the fry of fish which spawn in summer, obtained from raising-ponds.—In the same manner the fry of bleak, tench, crucians, and other cyprinoids, as well as of perch, can be successfully raised in large numbers in ponds with soft bottom; and the fry of perch-pike in ponds with sandy and gravelly bottom. We have seen that a properly constructed spawn-

ing pond of 0.1 hectare [one-fourth acre] will certainly produce 100,000 to 200,000 fry of carp and similar fish, but it cannot feed so large a number of young fish even for a few days. The fry should, therefore, soon after they have been hatched and have lost the umbilical sac, say, in about five days, be placed in the lake or river which is to be stocked. Wherever it can be done the contents of the pond should be allowed to flow slowly into the lake or river, and if possible at night, so the tender fish may escape the attention of their enemies. I do not consider it probable that these small fish will all be eaten by fish of prey, for all the large fish have once been small and been in danger of being devoured by larger fish. The fry may also be assigned to a larger pond and raised there. As has already been observed, 100,000 carp fry will in a raising-pond of 3 hectares [7½ acres] and in one month reach the length of several centimeters, and are much better able to defend themselves against their enemies. It should not be forgotten, however, that this requires thirty times more pond area, which used as a raising-pond could produce thirty times as large a quantity of fry. If, according to the old method, the spawning pond is not fished until autumn, 50,000 carp may be obtained from 1 hectare [2½ acres], but these fish will only measure 4 or 5 centimeters [1½ to 2 inches] in length. From my own experience I have gained the conviction that 250 such carp are amply sufficient to supply 1 hectare [2½ acres] of water area, even if it contains many fish of prey. In this manner I have in my own lakes created very productive carp fisheries. In planting the fry they should be distributed as much as possible over the entire water area; the water should be shallow and contain a good many aquatic plants, as this will insure a supply of food and protection against fish of prey.

The larger the carp the smaller should be the number placed in a pond. It may also pay to place large carp in open waters, even if the fish have to be bought. A very intelligent pond farmer in Schleswig-Holstein has for a long time been in the habit of buying a large number of carp measuring 20 centimeters [8 inches] and more in length. With these fish he stocks several lakes where fishing is easy, and in this manner he has become a wealthy man. A few years ago he placed in his lakes carp weighing 1½ pounds, and in the following winter he caught fish weighing 2½ pounds.

I am happy to say that at present a great interest is taken in the cultivation of our waters throughout all Germany, and that people begin to feel that we have some duties as regards our many and beautiful sheets of water. Would it be too much to hope that some liberal-minded landowners, and especially the largest landowner, the Government, will here and there on their fields and in their forests, along their rivers and lakes, establish a normal spawning pond of about one-tenth hectare [one-fourth acre], place in it three spawning carp, or other spawning fish, and annually place in our open waters 100,000 or more young fish?

What magnificent carp, both as to size and flavor, are occasionally caught in our streams! There can hardly be a doubt that they escaped, as young fry, from some pond farm, or were allowed to escape, because their number was too large.

Much has been said in our days about mirror, leather, and blue carp. They are generally thought to possess a more delicate flavor than carp with scales, and if properly raised they will grow just as rapidly. Dubisch justly considers it very important that only the best-formed carp and those which have grown most rapidly should be used for raising purposes.

CONSTRUCTION OF A POND.—Only in rare cases is a pond constructed by digging a great pit in the ground. Generally it is done by erecting a dike in the lowest place of some low ground. A pond may often be constructed at very slight expense by closing up the ditch which in former times has served to drain swamps or lakes. According to the different manner in which ponds are supplied with water, we distinguish:

Brook and river ponds, which are fed by running water;

Spring ponds, which are fed by springs; and

Sky ponds, which are fed by the rain and snow water or from ditches which dry up in hot weather.

The dike is made from the nearest material at hand, and at the same time the fish-pit is constructed. The best material is loam and clay. In sandy soil the dike and the pond should have a foundation of loam and clay, unless the supply of water is ample at all times, as otherwise there is danger that the water of the pond will gradually leak through the ground.

To drain the pond a pipe is laid right through the dike, which can be closed and opened on the water side. This pipe may be either of wood or of burnt clay or of bricks laid in cement. In sandy bottom the pipe must be tight, as otherwise the sand will enter and be carried away with the water, so that the dike begins to sink and the water of the pond flows out. In sandy bottom, wooden pipes should therefore always be set in cement. The tap-house is located at the end of the pipe on the water side. It consists of a wooden grate, which prevents the fish from entering the pipe, and of a safety-valve for letting off the water. Iron grates are not suitable, as they are soon destroyed by rust.

The fish-pit is a deep place near the tap-house, in which the fish congregate when the water is let off. It should be so constructed that it can be laid entirely dry, be large enough, and have a firm bottom. If the soil is loose, its bottom should therefore be strengthened by sand, gravel, and stones.

The outer pit is a deep place where the water goes after it has left the pipe. It is destined to receive the fish in case the grate has been damaged; and at the place where the water flows out of it there should

therefore be a grate. It is not advisable to let many fish get in the outer pit, as they are easily injured in passing through the pipe.

The bottom of the pond is crossed by numerous ditches, so that the water can everywhere flow off easily and rapidly, and that the fish can readily find their way to the fish-pit.

If a brook or river passes through the pond, an outer ditch is constructed along the edge of the pond, so that the superfluous water can be let off. Thereby stones, sand, and mud are kept away from the pond, which would otherwise gradually fill it. At times, when the water is very high, it may be led off through the outer ditch, and breaks in the dike may thus be avoided.

The pond fisheries take place during the cool season, either in spring or autumn, when there is no danger of frosts. It is well if during the fisheries fresh water can be led into the fish-pit, so as to refresh the fish at all times. After most of the water of the pond has been let off, and the water area has been reduced to about one-fifth or one-tenth of its original size, fishing commences. Care should be taken that the fish are at no time without water, by occasionally introducing fresh water into the pond. The edge of the fish-pit is covered with boards and reeds, on which are placed tubs filled with fresh water. From the nets the carp are put into these tubs, cleaned of dirt and slime, counted, put in kegs, and carried to their destination as rapidly as possible. As during the fisheries the water is stirred up and becomes turbid, and as the fish will more or less swallow some of this muddy water, it should be removed from their gills. If carp are to be transported a considerable distance, they should a few days previous be placed in clear running water where they do not receive any food, so that they may clean themselves thoroughly and not pollute the water during the journey with their excrements. The temperature of the water should be at most 10° R. (54½° F.), the lower the better. The quantity of water which is needed is calculated in the following manner from the weight of the fish and the length of the journey.

Excess of weight of water over the weight of the carp during a journey of 10 *to* 40 *hours.*

Length of time of journey.	Water should weigh—
10 hours	9 times the weight of the carp.
20 hours	12 times the weight of the carp.
30 hours	15 times the weight of the carp.
40 hours	18 times the weight of the carp.

Wilhelm Neue, of Neudamm, supplies wooden kegs, for transporting large fish, with a double bottom and pipe, for 16 marks [$3.80]; the same kegs with iron handles, 17 marks [$4.04]; the same kegs with a lid for ice, 19 marks [$4.52]; the same kegs (first quality), 20 marks [$4.76].

The otter is a dangerous enemy of the fish, and should be destroyed if one expects to raise any carp; herons, cormorants, ducks, and other

aquatic birds and animals will likewise diminish the productions of the spawning ponds. It is therefore necessary to fight these enemies energetically and persistently. In my Fish-Culture (*Fischzucht*) and my Manual of Fisheries and Fish-Culture (*Lehrbuch der Fischerei und Fischzucht*), which will be published during the coming summer, I have treated all these subjects at considerable length, and would, therefore, refer the reader to these works.

APPENDIX.

In several respects it is of great importance that ponds should lie dry as long as possible, and that the draining should be thorough.

It causes the spawning carp to spawn immediately; the principal cause of this may be that the soil is more thoroughly heated by the sun when it is quite dry. At Berneuchen the water in ponds treated in this manner had in the middle of May a temperature of $+16°$ R., whilst in ponds which had been filled with water for a longer time the temperature was only $+14°$ R. In consequence of this circumstance the carp spawned at once in the first-mentioned ponds, and produced an extraordinary quantity of fry, while in the other ponds they had not yet spawned on the 20th June.

If the ponds are allowed to lie dry, the increase of small crustaceans, on which the young fish principally feed, is greatly favored. All the ponds which I treated in this manner in a very short time literally swarmed with small crustaceans. Professor Benecke, of Königsberg, had the kindness to examine them, and found principally *Daphnia mucronata*, and, in smaller quantities, *Daphnia hyalina* and *Polyphemus oculus.* To explain the phenomenon I quote the following from Bronn "*Klassen und Ordnungen des Thierreichs*"—Classes and Orders of the Animal Kingdom—(Vol. V, part 1, p. 955): "The eggs of many branchiopods, especially those of the *Cladocera* and the Phyllopods, which by the females are partly deposited on plants, and partly simply ejected into the water, have to stay there a considerable time, sometimes even several months, till they develop, but are in many cases, *e. g.*, by the evaporation of the water in shallow ponds or ditches, laid entirely dry for a longer or shorter period. For most of the varieties of the Phyllopod the consequent imbedding of the eggs in the hardened mud seems to be an essential condition for their development."

Professor Benecke told me that the freezing of the eggs also seems to favor their development. Dubisch has observed for a number of years that in ponds which have been absolutely laid dry for a considerable period, a very large number of diminutive aquatic animals will develop immediately after the ponds have been filled with water. He is of opinion that it is an advantage to have the ponds filled with water for as short a period as possible prior to stocking them with young fry of the carp, in order that these small animals which are to serve as

food for the fry do not reach too large a size. It is of the greatest importance for the raising of all kinds of fish that we should be furnished the means of producing the natural food of the young fish in large quantities.

Frogs are hurtful in spawning-ponds, because they devour too many small fish. For larger carp, however, frogs form a very valuable article of food. For this purpose Dubisch gathers the spawn of frogs from the spawning-ponds and transfers it to the raising-ponds and growing-ponds. The larvæ of the frogs seem to be a favorite food of the carp, and to further its growth very much.

XXXVII.—POND CULTURE—THE FOOD AND SPAWNING OF CARP.*

By Adolph Gasch.

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In traveling through Central Europe the tourist frequently sees dikes in the gentle valleys of those regions, some of these dikes being well preserved and even covered with old trees, others very much damaged, occasionally plowed and cultivated like the flat pond area back of them. Pond culture must therefore have been carried on more extensively in former times, and a larger area must have been covered with water. Many ponds have been laid dry in the hope—justified in the beginning—of obtaining a larger income from agriculture, and the primitive way of treating ponds and fish was certainly not encouraging to pond farming.

Under the so-called "old method," unfortunately still employed in many places, it was customary during the first warm days of spring, as early as possible, to place several spawning carp in flat, sunny ponds; and if the weather was favorable, a number of very small carp, meas-

* *Beiträge zur Fischzucht und Teichwirthschaft.* From the *Deutsche Fischerei-Zeitung*, Vol. VI, Nos. 49, 51, and 52. Translated from the German by Herman Jacobson.

uring only an inch in length, was the result in autumn. But sometimes the eggs spoiled, or the tender fry were destroyed through lack of food or by animals, and the many spawners, to the great astonishment of the cultivators, produced but few offspring, which, because they did not have to share the scanty food with other fish, sometimes developed nicely, reached a length of 4 inches, and were known by the name of "May fry." If the summer was unfavorable, or if nature did not furnish certain conditions in the spawning-ponds, the fish did not spawn at all, and hope was deferred till the following year, or older fry, often very poor fish from the preceding year, had to be planted in order to raise carp. Frequently it was also expected of a pond to produce fry and at the same time to feed the larger carp. The characteristics of the "old method" are: great uncertainty, at best great irregularity, consequently small results quantitatively and qualitatively, and great loss of time.

At the present time matters are much better. Fish-culture and pond culture have become sciences, which are still in their infancy, and therefore far from being fully developed, but which undoubtedly have a great and promising future. By the artificial raising of fine food-fish, pond farmers, and more especially carp raisers, have been filled with a desire to become as independent as possible of nature. After many vain attempts we have again returned to nature, the great teacher, and have found that all which is needed to raise fish successfully is to give them those conditions which their instinct demands for spawning. It will be sufficient, in this place, to state this leading principle of modern fish-culture. To give all the details of my method, which had best be done privately, would not further the interests of fish-culture, because here likewise the old adage holds good that "there are many roads which lead to Rome," and because, improbable as it may appear, some other method may be discovered for carrying out the principle laid down above, which will answer the purpose still better.

If the natural requirements of the fish are properly met the result is certain. Within twenty-four hours after being placed in the pond they will spawn, and soon finish this process. Many people would like to know how this is done, but not much can be said on the subject. All that can be seen in the pond is that the fish rub against each other, and with their tails beat the water, which is thrown the higher the shallower the spawning place. But, as far as I know, it has not been definitely settled where the eggs are impregnated, whether inside or outside of the mother fish. According to Dubisch the grains of roe are impregnated inside the female fish, whereupon they immediately commence to swell, thereby exercising an increased pressure on the sides of the abdomen, which finally causes them to be ejected. Physiologically correct as this view seems to be, I cannot share it until I have become convinced by the microscopic investigations of an experienced naturalist, because it seems impossible that the spermatozoa can, during the short

period of twenty-four hours—the normal spawning time of the carp—effect the impregnation of from 600,000 to 700,000 grains of roe, which are to be ejected within that same period of time. If Mr. Dubisch is correct, the fish would be much less dependent on the temperature of the water than they really are. So far, therefore, I share the general opinion that the grains of roe are impregnated outside of the female fish. The denser the mass of spermatozoa in the water the larger will be the number of eggs which are impregnated, and having immediately become sticky, adhere to blades of grass, &c., and the less will be the number of eggs which fall to the bottom without being impregnated. The very circumstance that there are unimpregnated eggs seems to indicate the probability that the view generally entertained is correct.

It would be possible to get at the truth if a female fish engaged in spawning could immediately be examined microscopically. Professor Benecke, who has already put all fish-culturists under many obligations, would again earn our deepest gratitude by solving this exceedingly interesting problem. He has already proved the important fact that the spermatozoa of fish do not confine themselves to entering the ovary through the micropyle, but that they (at least in the case of the sticklebacks and probably also in the case of other fish) pierce the sides of the ovary in different places and thus effect impregnation. This peculiarity explains the fact that it is easier to produce bastards of fish than of higher animals, where, according to Professor Rueff, the spermatozoa strictly confine themselves to the micropyle, and here need a corresponding size and shape.

I consider it utterly impossible that carp can spawn thoroughly twice a year. The production of from 600,000 to 700,000 grains of roe in one year is such an enormous undertaking for a carp that more can hardly be expected. An exceptionally fine female carp, which, after it had already spawned in Kaniow, spawned in my pond for three years in succession, and which annually produced about 60,000 young carp, finally showed withered fins, an indication that this exorbitant production had been too much for her.

Wherever fish have been observed to spawn late in the season, they have been prevented from spawning in spring either by some slight bodily injury or by being still too young, or by having been placed previously in too cold water, where spawning, of course, could not take place until these evils had been remedied and all the necessary conditions had been supplied. As in analogy with other animals we must presume that both father and mother transmit some of their characteristics to their offspring, it will be necessary with peculiarly fine breeds to put only one male and one female together for the purpose of spawning. Wherever the main object is to produce a large number of fish it is customary, and entirely to the purpose, to put two or three milters to one spawner. There is considerable difference of opinion as to the proper proportion between the number of spawners and milters.

Thus, in the Upper Palatinate, people were, at least till I traveled through that country during last year, in the habit of putting ten and more milters to one spawner. Unfortunately it was also very common to put in the spawning pond other fish of different age. Unless certain conditions are complied with, a large number of spawners will not insure success.

Provided these conditions are all there, I would, according to my experience, advise to place in one spawning pond, for the purpose of producing 60,000 young carp, only one spawner and one or two milters, because this is amply sufficient, and, as will be seen from the following, is decidedly better for raising the young fish. If several set of spawners are put in a pond, or many milters to one spawner, it may happen that the fish, regardless of their possible offspring, and eager merely to satisfy their sexual desire, are too vehement in their sexual intercourse, and make the water muddy; and especially in ponds containing refuse from factories, some of this mud may settle on the eggs, produce fungi, and thus destroy them. But if the pond has been carefully selected and prepared for spawning, and if—the weather being favorable—everything goes on in its regular course, the young carp slip out of the eggs in from four to eight days, so that, as a rule, there will be young fry eight days after the spawners have been placed in the pond. The quicker the spawning and hatching is done the better it will be, as even in the seemingly cleanest spawning pond a number of enemies of the spawn and fry spring up as if by magic. The more plentiful and suitable the food which the young fish find in the pond, the quicker and more successfully will they develop and be able to escape from their enemies. If the raisers of fine food-fish would let them grow a little larger and stronger in their establishments, natural and good food, of course, being supplied in abundance, instead of placing the young fish in open waters when they are still quite tender, and when they are still impeded in their movements by the umbilical sac, the results of the culture of fine food-fish would soon become evident, and general confidence in artificial fish-culture, which, especially in a flat country, with many lakes and few natural spawning places, will always be of the greatest importance, would soon be restored.

To protect the young fish better against their enemies is not the only advantage of the new method. It is well known that good and ample food improves the shape of the fish, makes them broader, and favors the formation of flesh, so as to make the proportion between flesh and bones, *i. e.*, between useful and useless parts, more favorable. Moreover, a larger number of fish is produced for the pond area, stronger and (in the future) more productive fish are raised, as I have pointed out in my pamphlet published for the Berlin International Exposition of 1880, and finally, by constantly repeating this method, and by carefully selecting the very best fish for breeding, a well-formed and rapidly-growing breed of fish will be the result. The finer the kind of fish and

the younger and better fed the individual fish, the smaller will be the head, and the larger, broader, and fuller the body of the fish, without being shapeless. Thus, from large-headed carp, which are small for their age, a correct conclusion may be drawn as to bad management, a poor breed, and also poor ponds. Thus, in Prussia, on a large pond farm, which might easily have occupied a front rank among the German fish-cultural establishments, in spite of the fine and naturally favorable ponds, which, owing to the ignorance of the managers, had been sadly neglected, I found lean, small, thick-bellied fish, which even at the age of six or eight years hardly weighed one-half kilogram [1 pound], and of these only one-fourth of the number which, with proper management, the pond area might have produced.

In Bohemia I visited a pond farm which was otherwise well managed, but where the new method was not employed, and where the young fry, produced according to the old method, were in their raising ponds, *i. e.*, in their second year, favored so much by placing only a comparatively small number of fish in each pond, that, with unusually ample food, these fish developed very well, and in one year made up for lost time. The pond area used for this purpose, however, was too large, so that finally the fish intended for the market had less area than the fish which were still passing through the raising process, while the reverse should have been the case. It is evident that this way of managing, although momentarily having a good effect, is nevertheless very expensive. Better results, and in a cheaper way, are reached by the new method, which is characterized by safety in the production of the fry, by its excellent quality, and by a great saving of time.

From time immemorial it has naturally been the object to favor the growth of fish, especially those intended for the table, by supplying them with plenty of food outside of that found in the ponds, and it was recommended to throw in the ponds the excrements of cattle, malt, boiled potatoes, turnips, meat, ground meat, &c. Thus, about fifteen years ago, on a pond farm belonging to Archduke Albrecht, of Austria, a large horse slaughter-house was established, where cheap horse flesh was chopped fine by machinery, and in that condition ed to the fish. In the beginning the fish ate a little of it, but fin lly refused it altogether; the water became putrid and injurious to the fish, and it was soon found an urgent necessity to return to the natural food contained in the ponds, which, of course, was not so abundant, but much more wholesome. Of late years, also, fish-culturists, especially Carl Nicklas, have taken great pains to prove the advantage of the artificial feeding of fish in ponds, and have proposed different mixtures of food.

Although these suggestions are well-meant, I cannot agree with them, because as a rule it is erroneous from an economical point of view to give to fish articles of food which might be used otherwise, especially when it is very questionable whether the results of employing such food will correspond to its cost. In my opinion, nothing but refuse and ar-

ticles of food which cannot find any other use should be given to fish, and even then only exceptionally, always, of course, provided that the fish will readily take to this food and derive some benefit therefrom; but even then one would always run the risk of polluting the water and injuring the fish rather than benefiting them.

To show incontrovertibly the usefulness of employing such artificial food for fish, an Emil Wolf or Grouven would have to treat of this subject. As long as this is not the case, and all the results are based merely on more or less arbitrary suppositions, because in making experiments the natural, vegetable, and animal food contained in the ponds has nowhere been taken into account, it is better, for the present at least, to stick to the natural food, and to put the powerful productiveness of nature to the best possible use. I would, in this connection, direct attention to the easy way in which myriads of infusoria can be produced, and to the, unfortunately not entirely voluntary, production of various kinds of flies, gnats, and other insects. So far, however, we fish-culturists are very one-sided persons. If we are to fulfil our duty in the highest sense of the word we must aim at being at the same time raisers of insects, mollusks, &c., so that we can at all times supply our fish with healthy, palatable, and cheap food.

I again appeal to the kindness of men of science, like Dr. Brehm, Professor Semper, Professor Jaeger, and Professor Taschenberg, to aid us with their observations and advice, whereby their highly interesting and instructive studies will become of great practical value. If we could get so far as to enable us to increase at will useful insects, &c., and to limit the increase of the hurtful ones, our fish production would reach a stage of which at present we have no idea.

There are other animals which, particularly the young ones, might be used for fish-food, and I may be permitted to call attention to a much maligned and misrepresented animal, and by showing its usefulness establish its reputation. I mean my old friend the frog, the large green, croaking inhabitant of our stagnant and slow-running waters, which tolerably early in the season produces young ones in every stagnant water. It has often been asserted that frogs are injurious to fish-culture, because they are said to devour the young fry of fish, and even competent authorities have in their books given methods for destroying the frogs and their young ones. I know fish-culturists who pay men to gather and kill the frogs, so as to avert the damage which they are thought to inflict. It is true that, like the fish of prey, the frog has fangs, and that it is one of our most voracious, inquisitive, and imprudent animals. Thus, by splashing in the water with a switch, the large water-frog may be lured from the middle of the pond to the edge, and, hoping to find a fish on the dry land or some other animal in trouble, it advances blindly and boldly, so as even to jump on the switch or the hand. The frog will devour any live animal that it can swallow, and shows a special liking for small carp, insects, larvæ, snails,

caterpillars, &c., and even its own young when still tadpoles; frogs will sometimes swallow several large cockchafers in rapid succession without chewing them, and through their unlimited voracity they will often fill their stomachs to such a degree as to make their sides appear inflamed. I once even saw a frog jump after a hedge-sparrow with the evident intention of swallowing it.

In spite of this, the damage done by frogs to our fish ponds is not very great, and sinks into utter insignificance when compared with their usefulness by destroying many hurtful insects. The frog can, at most, catch only those fish which in some way or other have got into shallow places, or sickly or crippled fish, which even if there were no frogs would never develop into healthy fish. The frog has no gills to aid it in catching any animal in the water; its eyes sit on the top of its head, indicating that nature has intended it to snatch its food principally from the surface of the water. For the little damage which the frog does by catching young fry it makes ample amends by furnishing, in the tadpoles, abundant and nutritive food for fish, and thus renders itself exceedingly useful to the fish-culturist. The carp has good teeth, and is fully able to masticate this food. It appears that cultivated fish to a certain degree like to mix their food; thus, the carp only devours a certain quantity of tadpoles, and until these are digested does not touch this article of food, which has led superficial observers to the conclusion that the carp does not eat any tadpoles. The little water-frog is of special importance to carp-culture, as it spawns late in summer, and, as its offspring serves as food for the young fry, which have grown somewhat larger, and greatly promotes their growth, I have the spawn of the water-frog gathered every year and placed in my ponds.

Although we are still far from the highest possible aim, and although the favorable results of the fisheries given in my pamphlet must not yet satisfy us, a pond area will even now, if we take into account its occasional use for agricultural purposes, yield a more regular and better income than mere agriculture. But if we succeed in furnishing fish during their second and third year with cheap and good food, in the manner indicated, our ponds will also during the period when they serve fish-cultural purposes, produce more fish, and consequently a greater income—fully as much as that yielded by meadow lands. Taking this into consideration, many a farmer who at present labors in vain with the heavy moist soil of his old and long-since abandoned ponds, will again put these ponds in good working order; and in doing this he will not suffer any loss, but, on the contrary, if he is a good manager, the result of the fisheries will soon pay his expenses and leave him some money over. One after the other our farmers will follow this example, and gradually our whole country will regain all its old water area.

It should also be borne in mind that in parts of the country which suffer from drought, ponds by their exhalations furnish the surrounding vegetation with ample moisture, and thus to some degree counter-

act the hurtful influence of the cutting down of the forests. The forests with their rich beds of moss and dry leaves were the natural water regulators, catching the rain and gradually, but continuously, returning it in the shape of springs and exhalations. In this manner they protected us, to a certain degree, against the entire drying out of the brooks and against devastating inundations. Large ponds may well serve as reservoirs, and partially make up for the general devastation of the forests, by receiving during inundations a considerable portion of the turbid water, by letting the fertile mud settle in them, thus benefiting both the fish and the crops, which are during some years to be raised in the ponds, and finally by gradually giving up the purer water to the lower country and thus proving a blessing in many ways.

APPENDIX F.

MISCELLANEOUS.

XXXVIII.—REPORT OF OPERATIONS AT SAINT JEROME STATION, IN LAYING OUT OYSTER PONDS, BY THE STEAMER FISH HAWK, IN 1883.

By Lieut. W. M. Wood, U. S. N., Commanding.

In obedience to your instructions, I left Washington in this vessel on the afternoon of Monday, 12th instant, bound for Saint Jerome Creek, to carry out, as far as possible, certain work, a memorandum of which was furnished me by Mr. Ferguson.

It was, briefly, to lay out the oyster ponds into small rectangles, sound out the various channels, plot the results on the charts, and afterwards fill the ponds with oysters taken from the bay.

We arrived off Saint Jerome's early Tuesday afternoon, and I at once arranged with W. C. Foxwell to cut and haul the necessary stakes to mark the ponds.

The weather was too bad to permit any dredging until Thursday, the 15th, and in the mean time I employed myself in laying out the ponds. The divisions were made 100 feet square, pond A containing forty-three whole and nine fractional ones; pond B, six whole and six fractional squares; and pond C, three squares near its head and one opposite the wharf.

In pond B all but 4, 5, and 6 are dry at low-water, and oysters planted on them will freeze during cold weather. The squares at head of pond C, numbered 1, 2, and 3, have a bottom of soft mud to the depth of 6 feet, except very near the shore, and therefore are not suitable for planting over their whole surface. The same is true to a less extent of the square opposite the wharf, numbered 4.

The squares are all marked by a stake at each corner, and in the center a stake bearing the number of the square. The positions of all three stakes are plotted on the tracing furnished, as well as the depth of the center of channel at low water.

Having been obliged to seek shelter in Cornfield Harbor on Wednesday night, I commenced dredging there on Thursday morning, and worked with indifferent success until noon, when I ran around to Saint Jerome's, and while the ship continued dredging there I went ashore and carried on the work above alluded to. During the night it came on to blow a gale from the northward and westward, which continued during the whole of Friday, the 16th.

It being necessary to leave our anchorage on account of the heavy swell setting in, I went on up the bay to Baltimore to coal, arriving there late Friday evening. Finished coaling Monday afternoon, and started down the bay, anchoring below Thomas Point at 10 p. m. with the intention of dredging there in the morning, but until late the next day we were shut in by a thick fog. When it lifted we found the schooner Louis Taulane, Capt. R. L. Shelton, of Crisfield, loaded with oysters, had run ashore on the point during the fog, and the captain at once applied to me for assistance. I did what I could at the time, but as the tide had fallen since he went ashore, could not pull him off until it rose again.

We dredged in his vicinity until just before dark, and then ran a line to him and set him afloat without difficulty. We got very few oysters here, as the ground, notwithstanding it is forbidden to the dredgers, is thoroughly worked out. I was told it was a favorite place to work secretly at night. As soon as we let go the schooner I ran to the mouth of Eastern Bay and anchored for the night, intending to dredge the following day off Poplar Island.

Again we were shut in by fog during all the first half of Wednesday, the 21st. The fog lifted at noon and we at once got under way and tried the Poplar Island bed, but found it so poor and stony that I gave it up after an hour's work and ran down to Parker's Creek, on the west side of the bay, and finished the day dredging there, catching but few oysters, but plenty of shells. Anchored that night off Governor's Run.

Dredged the whole of Thursday, the 22d, off Governor's Run; the oysters were scarce, but very fine.

Stopped work at at 5 p. m. and ran down to the mouth of the Patuxent for a harbor for the night. Got under way at 6.30 next morning and ran down to Saint Jerome, which our experience so far taught us to be the best dredging-ground.

We commenced dredging on our arrival there at 8.30 a. m., and at the same time the launch brought out the scow, and the oysters previously caught were put on it, and I accompanied them in and personally supervised the planting, the ship in the mean time continuing her work.

Worked in the same way during the next day, Saturday, the 24th, except that twice we were obliged to stop and anchor for two hours each time on account of thick fog. The oysters caught on Saturday afternoon I landed on Sunday morning with great difficulty on account of a rapidly increasing wind from the northeast, and, as soon as it was done, got under way and steamed into the Potomac on our way to Washington.

The Fish Hawk is not adapted for taking oysters in the great quantities that will be required for planting in ponds. She can operate but

one dredge at a time, is obliged to land it on a covered deck, cannot work well among a crowded fleet of dredgers, to whom she, as a steamer, is obliged to give the right of way, and has to transship her catch to a scow and tow them ashore, which can only be done in smooth water and with a fair tide up the cut. Under the most favorable circumstances, on a good bed and with plenty of room, she can take about 50 bushels per day, but probably cannot average more than 30.

The oysters run about 250 to the bushel, and 40 bushels is the least that will properly cover a square, and it will take five times that number to cover it thickly.

A small oyster dredger of 40 tons will take from 75 to 125 bushels a day. Some of these vessels are of light draft, and a few even flat-bottomed. One of them could be towed right up the cut and the oysters carried from its deck across the dike to the scow and then distributed. Therefore, as I understand that plant oysters can be put down at from 25 to 30 cents per bushel, I would suggest this as the quickest, best, and decidedly cheapest method of doing it.

On Saturday night we were boarded by boats from the schooners N. B. Anderson, Capt. J. W. Carew, Crisfield, and Ella Trigs, Capt. Thomas Mills, Baltimore. The former were without lights, their lanterns having both exploded, and the latter in need of provisions, which they had been unable to get. I loaned the Anderson a lantern, with directions to return it to Saint Jerome's station, and gave the Ella Trigs 25 pounds of flour and six cans of preserved meat.

Mr. Ferguson asked me to see what could be done with the artesian well they have attempted to sink at the station. I found that nothing had been done further to it by the Lookout's crew, as Walter Sauerhoff was afraid to get steam on the old boiler, which he was to have used for that purpose. I had Mr. Bailie examine the boiler, and he reports it as decidedly unsafe in its present condition, and it is so far gone that it is doubtful if it will be worth repairing.

I think the trouble with the well arises from the fact that it was sunk to its present depth and then left for some time, during which the earth packed tightly around the pipe, especially at the joints, where there are abrupt shoulders, and that corrosion took place over its whole surface. Now it will be difficult to move it either way.

While dredging off Governor's Run I sent a boat in and collected a number of fossil molluscæ and crustaceæ, which are abundant in the clay bluffs bordering the bay at that point, and if they are of sufficient interest will send them to the Smithsonian Institution.

Accompanying please find results of work in tabular form.

We arrived at the Washington navy-yard on Monday, the 26th instant, at 12.30 p. m.

Oyster-dredging table.

Date.	Locality.	Average number per bushel.	Per cent. of shells.	Total amount taken.	Remarks.
Nov. 15	Cornfield Harbor	300	.75	13	Worked a half day.
—	Off Saint Jerome Creek	275	.50	15	Do.
20	Off Thomas Point	250	.75	8	Foggy. Worked three hours.
21	Off Poplar Island	250	.50	2	Foggy. Worked one hour.
21	Off Parker's Creek	200	.90	2	Do.
22	Off Governor's Run	200	.40	15	Worked all day. Oysters scarce.
23	Off Saint Jerome Creek	250	.50	53	Worked all day.
24	......do	250	.50	35	Foggy three hours. Worked rest of day.

Table showing subdivision of ponds and the record of the 100-foot squares.

POND A, 43 WHOLE SQUARES.

No. of square.	Number bushels per square.	Average per bushel.	Locality taken from.	Character of bottom.
4	24	250	Saint Jerome Creek	Hard.

POND B, 6 SQUARES.

No. of square.	Number bushels per square.	Average per bushel.	Locality taken from.	Character of bottom.
1	....	....	....	Dry at low water.
2	....	....	....	Do.
3	....	....	....	Do.
4	20	250	Parker's Creek, Governor's Run, Thomas Point, Poplar Island.	Hard bottom.
5	30	250	Off Saint Jerome Creek	Slightly muddy.
6	35	250	......do	Do.

POND C, 4 SQUARES.

No. of square.	Number bushels per square.	Average per bushel.	Locality taken from.	Character of bottom.
1	10	300	Cornfield Harbor	Deep mud.
2	10	300	......do	Do.
3	....	....	....	Do.
4	20	275	Saint Jerome Creek	Hard near shore.

U. S. FISH COMMISSION STEAMER FISH HAWK,

Washington, D. C., November 26, 1883.

XXXIX.—SUGGESTIONS TO THE KEEPERS OF THE U. S. LIFE-SAVING STATIONS, LIGHT-HOUSES, AND LIGHT-SHIPS, AND TO OTHER OBSERVERS, RELATIVE TO THE BEST MEANS OF COLLECTING AND PRESERVING SPECIMENS OF WHALES AND PORPOISES.

By Frederick W. True,

Curator of Mammals in the U. S. National Museum.

ANALYSIS.

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PREFACE.

On account of the orders recently issued to the keepers of the life-saving stations by Superintendent S. I. Kimball, and to the keepers of the light-stations by Vice-Admiral Stephen C. Rowan, U. S. N., requesting that the stranding of large animals on the coast should be immediately telegraphed to the Smithsonian Institution, it has been thought desirable to offer certain suggestions as to the best mode of telegraphing, preserving specimens, &c., for the guidance of observers.*

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*CIRCULAR.—ASSISTANCE TO COMMISSION OF FISH AND FISHERIES.

[1883. Department No. 10. Life-Saving Service.]

TREASURY DEPARTMENT, U. S. LIFE-SAVING SERVICE,
Washington, D. C., February 2, 1883.

To the Keepers and Crews of U. S. Life-Saving Stations:

Your attention is called to the following letter, addressed to this office by Prof. Spencer F. Baird, U. S. Commissioner of Fish and Fisheries, and you are requested to render him all the assistance possible in furtherance of the objects specified therein not incompatible with the performance of your regular duties.

S. I. KIMBALL,
General Superintendent.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., November 13, 1882.

DEAR SIR: I beg leave to call your attention to a service, in the interest of science and of the fishing industry, that can readily be rendered by those connected with the life-saving stations.

As United States Commissioner of Fish and Fisheries, I am desirous of obtaining a complete collection (to be deposited in the National Museum) of illustrations of the various marine animals the occurrence or capture of which is only occasional. I refer more particularly to whales, porpoises, blackfish, grampuses, and the various other forms of the whale family. These are frequently thrown ashore by the storms, or stranded in shoals, or taken in weirs, but, beyond exciting a passing interest on the part of the bystanders, very little further is heard of them. In addition to these I may mention the great basking or bone shark, and any unknown or unidentified marine monsters, such as might possibly suggest the idea of the far-famed "sea-serpent."

I would ask, therefore, that instructions be given to the persons connected with the Life-Saving Service, during the period of official duty or at other times, to advise me promptly, by telegraph, of the appearance, in their vicinity, of any such animals, and to endeavor to keep them in proper condition, and prevent their being cut or otherwise mutilated until I can send some word. I would cheerfully pay the full value of the oil or blubber of these animals, so that there might be no inducement to cut them up. A telegram sent to the nearest station, addressed "Professor Baird, Washington, D. C.," will come to me without prepayment being required if marked "Government business, collect." If out of the reach of the telegraph, the announcement may be

The instructions herewith published relate to the cetaceans only, since it is to this group that a large proportion of the specimens hereafter obtained will in all probability belong, and also because requests for information concerning these animals have been already received from several keepers of stations. Similar requests having been also made by a number of captains of whaling-vessels, and by other persons, it has seemed best to make the suggestions available for all classes of observers.

The knowledge of the cetaceans has always been deficient, owing to the difficulty of obtaining a sufficient number of specimens and the

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sent by mail. On receipt of this communication, which should give some idea of the nature and condition of the specimen, I will at once respond—in some cases sending an expert to prepare the specimen for the Museum.

Some of these animals, if not too large, can be forwarded directly to Washington; others I may wish to have cast in plaster on the spot and the skeleton only removed.

I would also be glad to be informed, in a similar manner, of the first appearance, at tolerably long intervals, of schools of mackerel, menhaden, bluefish, porpoises, blackfish, &c.

Very truly yours,

SPENCER F. BAIRD.

S. I. KIMBALL, Esq.,
Gen'l Sup't Life-Saving Service, Washington.

CIRCULAR.—ASSISTANCE TO COMMISSION OF FISH AND FISHERIES.

[1883. Department No. 12. L.-H. Board No. 2, of 1883.]

TREASURY DEPARTMENT,
OFFICE OF THE LIGHT-HOUSE BOARD,
Washington, D. C., February 13, 1883.

To the Keepers of Light-stations:

Your attention is called to the following letter addressed to this office by Prof. Spencer F. Baird, U. S. Commissioner of Fish and Fisheries, and you are requested to render him all the assistance possible in furtherance of the objects specified therein not incompatible with the performance of your regular duties.

STEPHEN C. ROWAN,
Vice-Admiral, U. S. N., Chairman.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., November 13, 1882.

DEAR SIR: I beg leave to call your attention to a service, in the interest of science and of the fishing industry, that can readily be rendered by those connected with the Light-House Service.

As United States Commissioner of Fish and Fisheries, I am desirous of obtaining a complete collection (to be deposited in the National Museum) of illustrations of the various marine animals the occurrence or capture of which is only occasional. I refer more particularly to whales, porpoises, blackfish, grampuses, and the various other forms of the whale family. These are frequently thrown ashore by the storms, or stranded in shoals, or taken in weirs, but, beyond exciting a passing interest on the part of the bystanders, very little further is heard of them. In addition to these, I may mention the great basking or bone shark, and any unknown or unidentified

lack of room in which to store or display them. It is believed that the zeal displayed by a few American collectors if extended to others will greatly aid in removing the obscurity in which the cetaceans are involved, while in the National Museum may be found a suitable and ample storehouse for the material gathered.

The subjoined instructions have been drawn up by Mr. Frederick W. True, curator of mammals in the National Museum.

S. F. BAIRD,
Secretary of the Smithsonian Institution
and U. S. Fish Commissioner.

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marine monsters, such as might possibly suggest the idea of the far-famed "sea-serpent."

I would ask, therefore, that instructions be given to the persons connected with the Light-House Service to advise me promptly, by telegraph, of the appearance, in their vicinity, of any such animals, and to endeavor to keep them in proper condition, and prevent their being cut or otherwise mutilated until I can send some word. I would cheerfully pay the full value of the oil or blubber of these animals, so that there might be no inducement to cut them up. A telegram sent to the nearest station, addressed "Professor Baird, Washington, D. C.," will come to me without prepayment being required if marked "Government business, collect." If out of the reach of the telegraph, the announcement may be sent by mail. On receipt of this communication, which should give some idea of the nature and condition of the specimen, I will at once respond—in some cases sending an expert to prepare the specimen for the Museum.

Some of these animals, if not too large, can be forwarded directly to Washington; others I may wish to have cast in plaster on the spot and the skeleton only removed.

I would also be glad to be informed, in a similar manner, of the first appearance, at tolerably long intervals, of schools of mackerel, menhaden, bluefish, porpoises, blackfish, &c.

Very truly, yours,

SPENCER F. BAIRD.

Vice-Admiral STEPHEN C. ROWAN, U. S. N.,
Chairman of the Light-House Board, Washington, D. C.

INTRODUCTION.

The following instructions are intended primarily for the use of the keepers of the life-saving and light stations on the coast of the United States, but an attempt has been made to render them also available for all other persons who may be interested in collecting cetaceans. It is hoped that they are sufficiently clear, brief, and free from technical terms to render them intelligible to any person who carefully reads them. In the course of the development of their craft whale-fishermen have found it necessary and convenient to use a certain number of words in a special sense to designate different parts of a whale, but only a very few of these are used in this paper, and then with the proper explanation.

One great source of difficulty which zoölogists encounter in the study of whales and porpoises lies in the fact that in a large number of instances the external form of a species is known while the skeleton is not; or that the skull or skeleton has been collected but no notice taken of the external appearance. Observers would do well to hold this constantly in mind and to remember that if they are only able to collect, for example, the skull of a porpoise they will add immensely to its value by stating whether the animal to which it belonged had a rounded or pointed head, a hump or a fin on the back, or any other of the important external characters which are briefly summed up on p. 10.

Measurements and drawings also prove of the highest interest, since they frequently help to bring out certain important points which even a long description might fail to make clear.

A more careful study of the various kinds of whales and porpoises is sure to lead not only to a better knowledge of their natural relationships, but to a clearer understanding of their commercial value. There are indications of the presence on our coasts of a number of species, especially of the smaller kinds of cetaceans, which, if better known, might be made the basis of profitable industries.

In a recently published catalogue* I estimated the number of known kinds or species of whales and porpoises frequenting the coasts of North America at sixty-two, but in reviewing the matter again I am convinced that not more than fifty-six can with propriety be included in the list. Even of these fifty-six nominal species fully one-third rest upon no certain basis, and the question of their identity is an open one.

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* Special Catalogue of the London Fisheries Exhibition, section H, p. 7, Washington, 1884.

Only about eighteen species can be considered to be well-known, and the majority of these are forms which occur in European waters as well as on our own coasts, and have long been under observation. The number of species whose habits, variations, and distribution are thoroughly understood is still smaller. The commonest porpoise on our eastern coast is the so-called "herring-hog," "puffing pig," or "harbor porpoise," known to science as *Phocœna communis* (fig. 12, pl. iv). Another species which is also very common is the "bottle-nose dolphin," *Tursiops tursio* (fig. 6, pl. ii). The common dolphin, *Delphinus delphis* (fig. 7, pl. iii), which has been known from time immemorial, the black-fish, *Globiocephalus melas* (fig. 18, pl. vi), and a striped porpoise also appear to be very abundant along the Atlantic seaboard. On the Californian coast there are also a harbor porpoise, a common dolphin, and a striped porpoise, which are very abundant.

None of the large whalebone whales—the right whales, hump-backs, fin-backs, and sulphur-bottoms—can be said to be abundant on the coasts of the United States at the present day.

There are doubtless persons in many of the Atlantic fishing-towns who have had opportunities for observing the different Atlantic species under various conditions, and it is much to be regretted that more observations have not been recorded. The writings of Scammon have extended the general knowledge of the species occurring on the west coast far beyond that of those on the east coast.

There are certain names which have been used to designate so many different kinds of whales and porpoises that they ought to be avoided as much as possible. For example, the name "grampus" has been applied both to porpoises and to whales with whalebone, which are not more closely related than a horse and a cow. The word "blackfish" has been employed for any porpoise which is black. In reality the word "grampus" ought to be applied only to porpoises like that represented in fig. 17, pl. vi, and "blackfish" only to porpoises like that represented in fig. 18, pl. vi.

GENERAL OBSERVATIONS.

Observations on living specimens.—There are many general observations of value which may be made by voyagers and other observers, even when the species under observation cannot be exactly identified. Such relate, for example, to—

1. The number of individuals in a school.
2. The apparent equality or inequality of age and size of individuals of a school.
3. The movements in swimming, whether rolling, leaping, or otherwise.
4. The direction of the movement and the succession of different schools.

5. The rate of movement.

6. The rate of spouting or "blowing" and the phenomena accompanying that action, such as whistling, &c., or the height to which the column of spray is thrown.

Observations in the direction in which schools of the various species move at different seasons of the year are especially desirable and could be readily made by keepers of the life-saving stations and other observers on the coast.

Any observations on the breeding habits of the different species, the times of year and localities in which the young are brought forth, the size of the young at birth, the length of time they follow the mother, &c., are exceedingly important, as our knowledge on these subjects is still very defective.

Very little also is definitely known concerning the food of many species and the manner in which it is captured. Any facts bearing on this matter are well worth recording. The entire contents of the stomach should be placed in a bottle of alcohol when opportunity permits.

In addition to the few topics for investigation which have been alluded to there are many others of equal importance which will suggest themselves to the thoughtful observer. It will yet be a long time before we can say we know all that it is necessary to know about these rovers of the sea. It is indeed a strange fact that, while the external and internal peculiarities and the life-history of numberless insects and minute and lowly animals have been thoroughly investigated, many of these great beasts have been entirely neglected.

INSTRUCTIONS FOR THE USE OF THE LIFE-SAVING AND LIGHT-HOUSE SERVICES.

Stranded whales.—If a dead whale is seen floating in on the tide observe whether it is followed by porpoises and sharks or by its young.

Color.—When it strands the color of its head, back, belly, both sides of the flippers and tail, should be immediately observed and recorded.

Securing the specimen.—If the specimen is liable to be washed out to sea by succeeding tides, fasten it by the tail (*never by the flippers or jaw, unless unavoidable.*) Of course, if the specimen is small, it can be dragged up the beach out of reach of the water or even be placed in an ice-house.

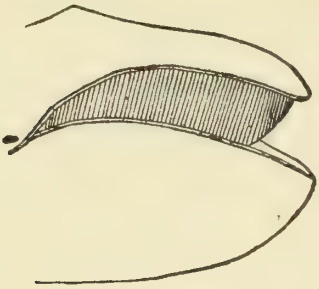
Use of sand.—If the latter course cannot be taken, cover the specimen with a thick coat of *wet* sand or seaweed.

Telegraphing.—In telegraphing to Washington it is especially desirable that the following code should be used, since thereby it will be possible for the zoölogists at the Smithsonian Institution to judge of the appearance and value of specimens and to determine whether persons ought to be sent to take casts or prepare the skeleton.

Address.—All telegrams should be addressed to PROF. S. F. BAIRD, SMITHSONIAN INSTITUTION, WASHINGTON, D. C.

TELEGRAPHIC CODE.

Observe the following characters and telegraph those which are present, *using simply the numbers* instead of the words. The outlines at the left of the page are intended to aid in fixing the characters.

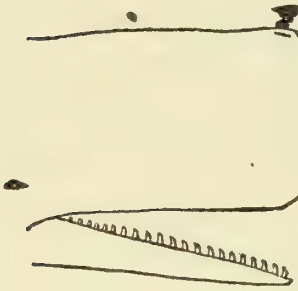


1.

1. Whalebone in the mouth.

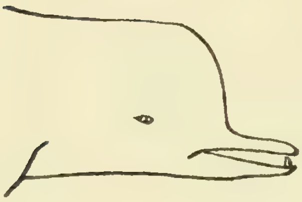
2.

2. Teeth in both jaws.



3.

3. Teeth in the lower jaw only, but more than two or four.



.4

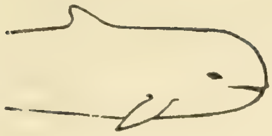
4. Teeth, only two or four, at the end of the lower jaw.

5.

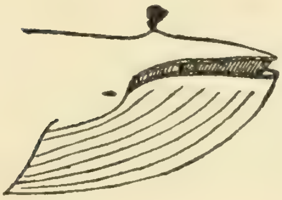
5. Teeth, only two or four, in the side of the lower jaw.

6.

6. No teeth nor whalebone in the jaws.


7.

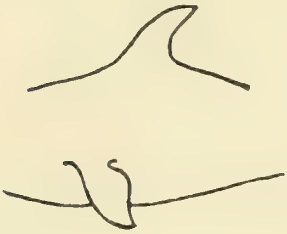
7. Throat smooth.


8.

8. Throat with folds.


9.

9. Back with a hump.


10.

10. Back with a fin.


11.

11. Back smooth.


12.

12. Head rounded.


13.

13. Head with a beak.


14.

14. Head pointed.

Measurements.—In addition to the foregoing characters the following measurements should be recorded, and those bearing the letters A, B, E, and F (if a back-fin is present) telegraphed:

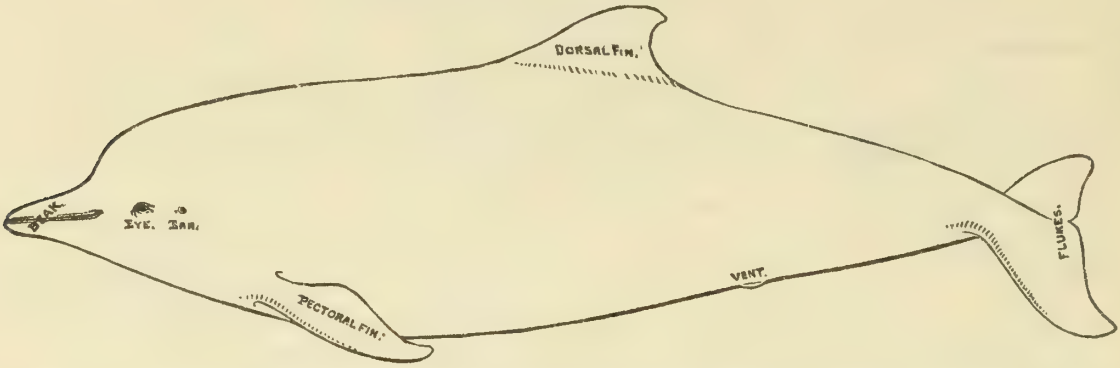


FIG. 1.—Showing the organs and regions of the body to which special names are applied.

Measurements in feet and inches.

* A. Length over all (total)			
* B. Length of the mouth			
C. Breadth across the flukes from tip to tip (straight)			
D. Depth of flukes from before backward			
* E. Length of flipper (pectoral fin)			
* F. Height of back-fin			
G. Girth at largest part			
H. Distance from the tip of the snout to the base of the back-fin			
I. Length of longest whalebone (when present)			

* These are the most important measurements.

Teeth.—Also telegraph *invariably.*

Z. The total number of teeth.

The following telegram may serve as a model:

[A telegram showing the use of the symbols.]

"WESTERN UNION TELEGRAPH COMPANY,
"*Cape May, N. J., January* 1, 1885.

"Prof. S. F. BAIRD,
"*Smithsonian Institution, Washington, D. C.:*

"Female porpoise stranded near Station Ten this morning. Numbers four, seven, ten, thirteen. A, twelve feet eight inches; Z, two.

"JOHN SMITH,
"*Keeper.*"

Telegram expanded.—The foregoing telegram expanded would read as follows: "A female porpoise stranded near Life-saving Station No. 10 this morning. It has (4) teeth to the number of two or four in the lower jaw only. (7) The belly is smooth. (10) The back carries a fin. (13) The head is beaked. (A) Total length, 12 feet 8 inches. (Z) Whole number of teeth, two."

METHOD OF PACKING FRESH SPECIMENS.

Packing.—If a response is received from Washington requesting that a fresh specimen or specimens be shipped, the latter should be packed in ice, sea-weed, or sawdust.

Use of ice, sea-weed, sawdust, and salt.—Ice is almost indispensable in

warm weather, but if it cannot be gotten, sea-weed may be substituted. As sea-weed is not thrown up plentifully on all parts of the coast, sawdust or even salt may be used. Sawdust should be wet.

Removing the entrails.—If specimens are packed in salt, sea-weed, or sawdust it is necessary in warm weather to remove the entrails and fill the cavity with salt. In making an opening for this purpose care should be taken not to allow the slit to extend too far toward the head, and thus to endanger the breast-bone.

SELECTIONS OF SPECIMENS FROM A SCHOOL.

In case of the stranding of a large school at a point from which it is possible to send specimens to Washington at small expense, a full-grown male and female and a young specimen should be selected. (The female may be known by the presence of a short slit on each side of the vent, in which the teats or mammæ are concealed.)

Measurements.—A few measurements of a considerable number of specimens would also be desirable.

PREPARATION OF A SKELETON.

In some cases the distance from Washington or other obstacles will prevent the sending of fresh specimens. Under such circumstances the skin and flesh should be roughly removed from the skeleton and the latter packed in dry sea-weed or sawdust. The more oily a specimen is and the longer it will be on the road the more carefully it should be cleaned. This is for the reason that the heat of the oil destroys the bones as if in a slow fire.

The hind limbs.—Special search should be made for the rudimentary bones of the hind limbs which lie in the flesh half-way between the

FIG. 2.—Pelvic bone of a porpoise—natural size.

backbone and the vent. The neglect to preserve these bones renders many specimens in museums imperfect. In a porpoise 6 or 8 feet long their length would not exceed 3 or 4 inches. See also page 14.

SHIPPING DIRECTIONS.

Address.—Fresh specimens should be in all cases shipped by express,* addressed to Prof. S. F. BAIRD, SMITHSONIAN INSTITUTION, WASHINGTON, D. C., and marked "*perishable.*"

What to do when persons are sent from Washington.—If a response is received stating that persons will be sent to care for the specimen nothing is necessary to be done but to keep it as far as possible buried in wet sand.

INSTRUCTIONS FOR THE USE OF CAPTAINS OF WHALING VESSELS AND OTHER OBSERVERS AND COLLECTORS.

Records.—Observers at sea having neither time nor opportunity to preserve specimens might with good result record (in a book kept for the purpose) some of the characters and measurements included in the scheme on pp. 10–12.

Points of interest.—Among the points of interest not referred to on these pages are (*a*) the shape, color of the body, head, fins, and flukes, and the color of inside of the mouth; (*b*) the size and shape of the teeth, or the length, breadth, fineness, and color of the whalebone; (*c*) the size and color of the eye; (*d*) the size and shape of the blow-hole or blow-holes. Such observations should always be accompanied by a record of the sex of the specimen and the date upon which and the locality in which observed.

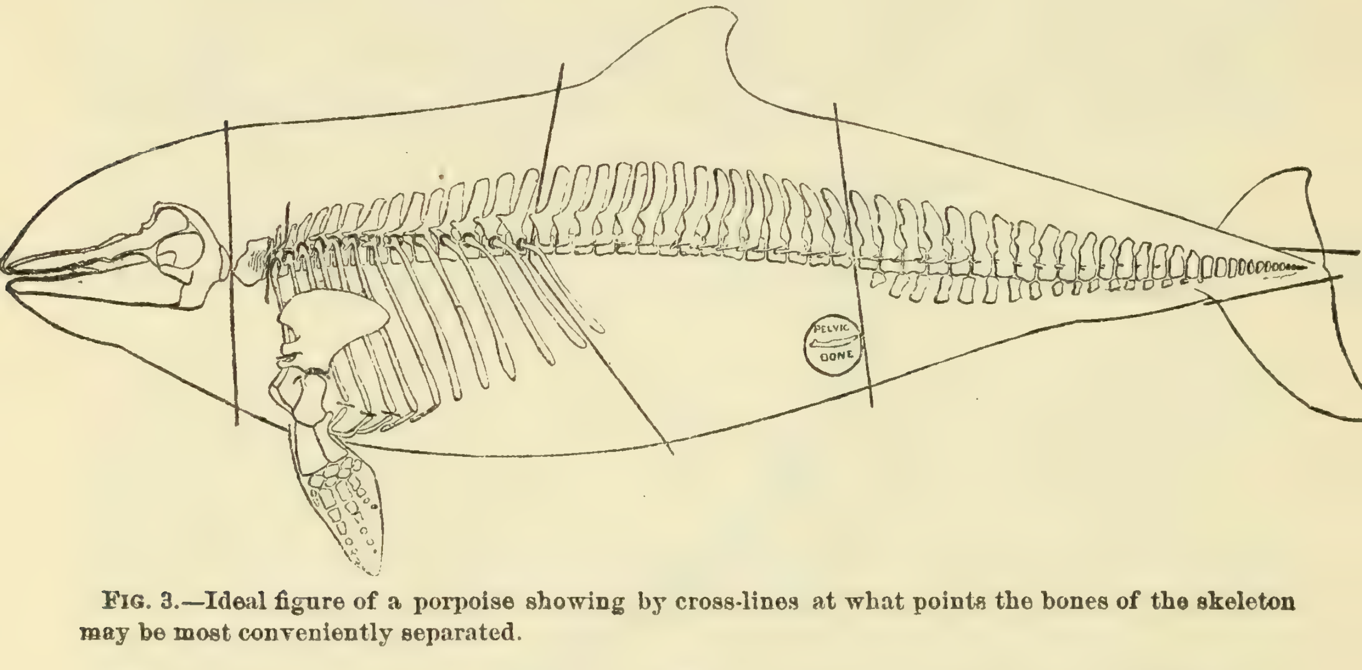


FIG. 3.—Ideal figure of a porpoise showing by cross-lines at what points the bones of the skeleton may be most conveniently separated.

The skeleton.—If specimens can be preserved, the entire skeleton is, of course, the most to be desired, provided that a record is kept of the external appearance of the animals. It is taken for granted that skeletons of very large whales cannot be preserved except under extraor-

*If too large to be boxed they should be sewed up in canvas, and thus protected on the journey.

dinary circumstances; and what follows relates to the dolphins, porpoises, and other small cetaceans.

The pelvic bones.—Care should be taken (as already intimated on a prior page) to obtain the pelvic bones or rudiments of the hind limbs which lie in the flesh on each side of and near to the vent.

The pectorals.—The flippers may be separated from the shoulder-blade by cutting close to the body and laying bare the joint; they do not need any preparation.

The flukes.—Each of the flukes should be cut off near the body (see figure 3) and thrown away.

The hind part of the body.—The tail, from the vent backwards, may be cut loose from the body in one piece, and does not need any further preparation, except in very large specimens.

The head.—The head should be severed from the body, care being taken not to injure the tongue or hyoid bones of the throat.

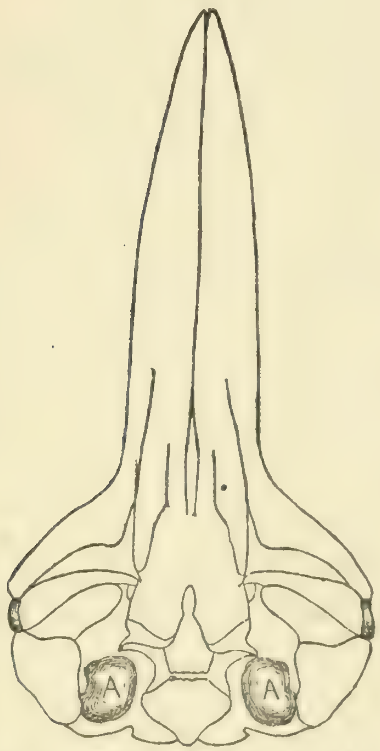


FIG. 4.—View of the under side of the skull of a whale, showing the position of A A, the ear-bones; B B, the cheek-bones.

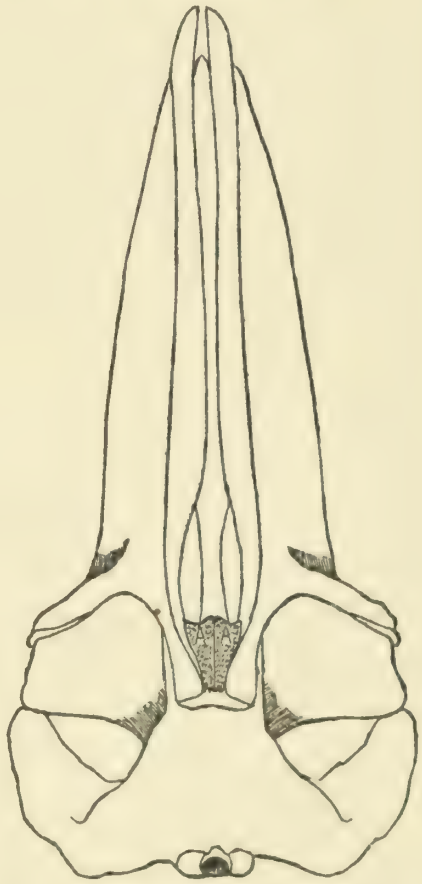


FIG. 5.—View of the upper side of the skull of a whale, showing the position of A A, the nose-bones.

The ribs.—The flesh should then be roughly removed from the head and trunk, the ribs cut loose at their junction with the backbone and with the cartilages of the breast bone.

Packing the skeleton.—The whole specimen should then be dried for a short time and packed in barrels or other receptacles with a mixture of dry saw-dust and salt, and a card or other label bearing the sex, date, and locality.

Tools.—All the operations referred to should be performed with a

knife; *never with a saw or ax.* If there is time and inclination, instead of packing the roughed-out skeleton it would be better to soak the bones in water and scrape them from time to time with a dull knife. As already stated on p. 13, the care with which a specimen should be prepared depends upon the time which will elapse before it will reach its destination and the amount of oil which it contains.

Most desirable parts.—If it is not feasible to preserve the whole skeleton, the most desirable parts are the skull, flippers, lower jaw, ear-bones, or (in the whalebone whales) the nose-bones or pieces of whalebone.

The skull.—The skull should have the flesh roughly removed and if possible be soaked and scraped. Care should be taken not to break the delicate malar or cheek bone which forms the lower border of the eye-socket. The flippers need no preparation unless large; they may be dried.

Ear-bones.—The ear-bones are represented by two rounded or oblong bony masses at the back and under part of the skull. With a little care they are readily detached. (See fig. 4, p. 15.)

Nose-bones.—The nose-bones of the large whalebone whales lie at the extreme upper end of the great front opening of the nose, in the middle line of the skull. In large specimens they do not exceed four or five inches in length. They are very important in identifying species. (See fig. 5, p. 15.)

A KEY FOR THE IDENTIFICATION OF SPECIMENS.

In the subjoined key for the identification of the different tribes or genera of whales and porpoises an attempt has been made to employ only such characters as relate to the external appearance. This is somewhat difficult for the reason that some genera which are very much alike externally differ very much internally. Of course, the genera whose names stand near each other in this key are not necessarily closely related; in the classification which is given on page 19 an attempt is made to bring the related forms together as well as may be, when the names are placed in a line, one after another. The figures (see plates I–XI) to which the numbers in parentheses relate are intended to show as nearly as may be the general form of some characteristic species of each genus. They have been selected from the best figures which are to be found in the available scientific literature, and from photographs and sketches, but some are known to be imperfect. Of the genera *Agaphelus*, *Neobalæna*, and *Feresia* no figures exist. The lengths given are those of average adult specimens.

Key to the names of genera.

[To use this key begin at a^1, and if the specimen in hand *agrees* with the description there given, pass to the letter with the *next figure* which stands *immediately underneath.* If the specimen does *not* agree with

the description pass instead to the *next letter of the alphabet* which bears the *same* number.]

a^1. Whalebone in the upper jaw; no teeth; blow-holes, two.

a^2. No fin or hump on the back; no furrows on the belly.

a^3. Whalebone very long (7 to 12 feet); color of body black.

Balæna. Bowhead and Right whales. (32.) (Arctic and temperate seas.)

b^3. Whalebone short (14 to 16 inches), yellow; color of body gray, mottled.

Rhachianectes. The Gray whale. (27.) (North Pacific Ocean.)

c^3. Whalebone short and white; color of body black above; base of pectorals white, tips black.. *Agaphelus.* Scragg whale.? (North Atlantic Ocean.)

Neobalæna. Pygmy bowhead. [Only the bones and whalebone known.] (New Zealand.)

b^2. A hump on the back; furrows on the belly; pectorals as long as the head.

Megaptera. Humpback whales. (28.) (All seas.)

c^2. A fin on the back. Furrows on the belly. Pectorals shorter than the head.

d^3. Fin on the back about as near to the head as to the tail. A band of white across the pectoral (?).

Balænoptera. Piked whales. (29.) (All seas.)

e^3. Fin on the back much nearer to the tail than to the head.

Physalus and *Sibbaldius.* Fin-back and sulphur-bottom whales. (30 and 31.) (All seas.)

b^1. No whalebone in the mouth.

d^2. No teeth. One (or occasionally two) twisted tusk 5 to 8 feet long, protruding from the jaw. Color of the body light, mottled.

Monodon. The Narwhal. (15.) (Arctic Seas.)

e^2. No long tusk. No visible teeth in either jaw. Head with a beak. A small fin on the back nearer to the tail than to the head. Size rather large (16 to 33 feet).

Hyperoödon (26). *Ziphius* (female and young male); *Mesoplodon* (female and young male). (24.) Bottle-nosed whales. (All seas.)

f^2. Teeth in the lower jaw only.

f^3. Visible teeth only *two*; in the *tip* of the lower jaw.

Ziphius (adult male). Bottled-nosed whales. (23.) (All seas.)

g^3. Visible teeth only *two*; in the *side* of the lower jaw.

Mesoplodon (adult male). Bottle-nosed whales. (24a.) (North Atlantic and North Pacific Oceans.)

h^3. Visible teeth only *four*; near the tip of the lower jaw.

Berardius. (adult male). (25.) (New Zealand and Bering Island.)

i^3. Teeth 6 to 14, not sharp-pointed. Head rounded. Fin at the middle of the back; moderate.

Grampus. The grampuses. (17.) (Temperate seas.)

j^3. Teeth 18 to 30, very sharp-pointed. Head pointed. Fin on the back nearer to the tail than to the head; small.

Kogia. Pygmy sperm whale. (22.) (Temperate and tropical seas.)

k^3. Teeth 40 to 50; very large and blunt. Head square. Blow-holes at the end of the snout. Body very large.
Physeter. The sperm whale. (21.) (Temperate and tropical seas.)

g^2. Teeth in both jaws.
l^3. Head without a distinct long beak and more or less rounded and globular.
a^4. Teeth flattened.
a^5. A fin on the back.
Phocœna. Common porpoises; puffing-pigs. (12.) (Coasts of all continents.)
b^5. No fin on the back.
Neomeris. Finless porpoises. (13.) (Indian Ocean and coast of Japan.)
b^4. Teeth round.
c^5. A fin on the back.
a^6. Teeth from 16 to 24 in each jaw.
a^7. Fin on the back much higher than the pectorals are long.
Orca. Killers. (20.) (All seas.)
b^7. Fin on the back moderate.
a^8. Head very round. Row of teeth not extending to the corner of the mouth. Pectorals long and narrow.
Globiocephalus. Blackfish. (18.) (All seas.)
b^8. Head very round. Row of teeth extending back to the corner of the mouth. Pectorals short.
Orcella. (16.) (Coast and rivers of India.)
c^8. Head sloping. Row of teeth extending back to the corner of the mouth. Pectorals short.
*Pseudorca.** (19.) (Coast of Europe and of New Zealand.)
b^6. Teeth in each jaw, 44 to 66.
c^7. Edges of the fin on the back curved (*i. e.*, the dorsal fin falcate).
Lagenorhynchus. Striped porpoises. (10.) (All seas.)
d^7. Edges of the fin on the back not curved (*i. e.*, the dorsal fin triangular).
Cephalorhynchus. (11.) (Temperate Atlantic and Pacific Oceans.)
d^5. No fin on the back. Color, white.
Beluga. The White whale. (14.) (Arctic Seas.)
m^3. Head with a distinct elongated beak.
c^4. A distinct fin on the back, not in the form of a low ridge.
e^5. Bone of the tip of the lower jaw extending as far back as the fifth or sixth tooth or much further (*i. e.*, symphysis of the mandible elongate).
c^6. Teeth about 50 in each jaw.
Steno. Long-beaked dolphins. (5.) (Temperate and tropical seas.)
d^6. Teeth about 66 in each jaw.
Sotalia. River dolphins. (4.) (Rivers of tropical America and southeastern Asia.)
e^6. Teeth from 100 to 120 in each jaw.
Pontoporia. The Pontoporia. (3.) (Coast of the Argentine Republic, South America.)
f^5. Bone of the tip of the lower jaw not extending back to the 5th or 6th tooth (*i. e.*, symphysis of the mandible not elongate).

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* Another genus, named *Feresia*, is known only from two skulls, one of which came from the "South Seas." There are about 24 teeth in each jaw. The form will probably prove to be somewhat like that of *Pseudorca*.

f^6. Teeth about 44 in each jaw.

Tursiops. Bottle-nosed dolphins. (6.) (All seas.)

g^6. Teeth from 80 to 120 in each jaw.

Prodelphinus and *Delphinus*. Common dolphins. (8 and 7.) (Coasts of all continents.)

d^4. No fin on the back, or simply a low ridge.

g^5. Pectorals pointed at the end.

h^6. Teeth 50 to 70 in each jaw. A ridge on the back. Beak long.

Inia. The Inia. (2.) (Upper Amazon River and tributaries, South America.)

i^6. Teeth about 80 in each jaw. Beak short.

Leucorhamphus. Right-whale porpoises. (9.) (Atlantic and Pacific Oceans.)

h^5. Pectorals broad and truncated. Eyes very small (⅛ inch). Beak turned up at the end.

Platanista. The Susu. (1.) (Rivers of India.)

A SYSTEMATIC ARRANGEMENT OF THE GENERA AND HIGHER DIVISIONS OF CETACEANS.

Order CETE.—Whales or Cetaceans.

Sub-order DENTICETE.—Toothed Whales.

Family PLATANISTIDÆ.—The River Dolphins.

1. *Platanista*, Wagler.—The Susu.
   The Ganges and Indus Rivers, India.
2. *Inia*, D'Orbigny.—The Inia.
   The Amazon River and its tributaries.
3. *Pontoporia*, Gray.—The Pontoporia.
   Coast of the Argentine Republic.

Family DELPHINIDÆ.—Porpoises and Dolphins.

4. *Sotalia*, Gray.—River dolphins.
   Rivers of South America and India.
5. *Steno*, Gray.—Long-beaked dolphins.
   Temperate and tropical seas.
6. *Tursiops*, Gervais.—Bottle-nosed dolphins.
   All seas.
7. *Delphinus*, Linné.—Common dolphins.
   Coasts of all continents.
8. *Prodelphinus*, Gervais.—Common dolphins.
   All seas.
9. *Leucorhamphus*, Lilljeborg.—Right-whale porpoises.
   Atlantic and Pacific Oceans.
10. *Lagenorhynchus*, Gray.—Striped dolphins.
    All seas.

11. *Cephalorhynchus*, Cuvier.—White-marked porpoises.
Temperate Atlantic and Pacific Oceans.
12. *Phocœna*, Cuvier.—Common porpoises.
All seas.
13. *Neomeris*, Gray.
Indian Ocean and coast of Japan.
14. *Delphinapterus*, Lacépède.—The Beluga or White whale.
Arctic seas.
15. *Monodon*, Linné.—The Narwhal.
Arctic seas.
16. *Orcella*, Gray.
Rivers and coast of India.
17. *Grampus*, Gray.—Grampuses.
Temperate seas.
18. *Globiocephalus*, Lesson.—Blackfish.
All seas.
19. *Pseudorca*, Reinhardt.—False killers.
Northern Europe; Tasmania.
20. *Orca*, Gray.—Killers.
All seas.
20*a*. *Feresia*, Gray.

Family PHYSETERIDÆ.—The Sperm whales.

21. *Physeter*, Linné.—The Sperm whale.
Temperate and tropical seas.
22. *Kogia*, Gray.—The Pygmy Sperm whale.
Temperate and tropical seas.

Family ZIPHIIDÆ.—Bottle-nose whales.

23. *Ziphius*, Cuvier.
All seas.
24. *Mesoplodon*, Gervais.
Atlantic and Pacific Oceans.
25. *Berardius*, Duvernoy.—Berard's whale.
New Zealand; Bering Island.
26. *Hyperoödon*, Lacépède.—Bottle-nose whale.
North Atlantic Ocean.

Suborder MYSTICETE.—The Whalebone whales.

Family BALÆNIDÆ.

27. *Rhachianectes*, Cope.—The Devil-fish or Gray whale.
North Pacific Ocean.
27*a*. *Agaphelus*, Cope.—The Scragg whale (?)
North Atlantic Ocean.

28. *Megaptera*, Gray.—Humpback whales.
    All seas.
29. *Balænoptera*, Lacépède.—Piked whales.
    All seas.
30. *Physalus*, Gray.—Fin-back whales.
    All seas.
31. *Sibbaldius*, Gray.—Sulphur-bottom whales.
    All seas.
32. *Balæna*, Linné.—Bowhead and Right whales.
    Arctic and temperate seas.
33. *Neobalæna*, Gray.—Pygmy Bowhead.
    New Zealand seas.

A CHECK-LIST OF THE SPECIES OF CETACEANS WHICH OCCUR ON THE COASTS OF NORTH AMERICA.

Order CETE.

Suborder DENTICETE.

Family DELPHINIDÆ.

Sotalia pallida, Gervais. Florida (?)

? *Steno fuscus*, Gray. Cuba.

Steno compressus, Gray. Gulf of Mexico (?)

Delphinus Bairdii, Dall. Baird's Dolphin. Coast of California.

Delphinus delphis, Linné. Common Dolphin. Atlantic Ocean.

? *Delphinus albirostratrus*, Peale.

Delphinus janira, Gray. The Janira. Newfoundland. (Gray.)

? *Prodelphinus euphrosyne*, (Gray) True. North Atlantic Ocean.

? *Leucorhamphus borealis*, (Peale) Gill. Right-whale Porpoise. Pacific coast of North America.

Lagenorhynchus acutus, Gray. Eschricht's Dolphin. North Atlantic Ocean.

Lagenorhynchus albirostris, Gray. White-beaked Bottlenose. North Atlantic Ocean.

Lagenorhynchus obliquidens, Gill. Striped or common Dolphin. Pacific coast of the United States.

? *Lagenorhynchus tricolea*, Gray. West coast of North America.

Lagenorhynchus gubernator, Cope. Skunk Porpoise. Coast of New England.

Lagenorhynchus perspicillatus, Cope. Coast of New England.

Tursiops tursio, (Bonnaterre) Van Ben. and Gervais. Bottle-nose Dolphin. North Atlantic Ocean.

Tursiops Gillii, Dall. Cow-fish. Pacific coast of the United States.

Tursiops erebennus, (Cope) Gill. Black Dolphin. Atlantic coast of the United States.

Orca gladiator, (Bonnaterre) Gray. Atlantic Killer. Atlantic Ocean.

Orca atra, Cope. Pacific Killer. Pacific coast of North America.

? *Orca pacifica*, Gray. North Pacific Ocean.

Globiocephalus melas, (Traill). Blackfish. North Atlantic Ocean.

Globiocephalus brachypterus, Cope. Coast of New Jersey.

Globiocephalus Scammoni, Cope. Pacific coast of North America and southwards.

Grampus griseus, (Cuvier) Gray. Grampus. North Atlantic Ocean.

Grampus Stearnsii, Dall. Mottled or White-headed Grampus. Pacific coast of North America.

Delphinapterus catodon, (Linné) Gill. White Whale. Arctic and Subarctic seas.

Monodon monoceros, Linné. Narwhal. Arctic seas.

Phocœna communis, Lesson. Puffing Pig. Herring Hog. North Atlantic Ocean.

Phocœna lineata, Cope. Striped Porpoise. Atlantic coast of the United States.

Phocœna vomerina, Gill. California Bay Porpoise. Pacific coast of the United States.

Family ZIPHIIDÆ.—Bottle-nosed Whales.

Berardius Bairdii, Stejneger. Bering Island.

Hyperoodon rostratum, (Chemnitz) Wesmael. Bottle-nose Whale. North Atlantic Ocean.

Ziphius cavirostris, Cuvier. Temperate and tropical seas.

? *Ziphius semijunctus*, (Cope). Atlantic Ocean.

Ziphius Grebnitzkii, Stejneger. Grebnitzki's Bottle-nose Whale. Bering Island.

Mesoplodon Sowerbiensis, Gervais. Temperate north Atlantic.

Family PHYSETERIDÆ.—The Sperm Whales.

Physeter macrocephalus, Linné. Sperm Whale. Temperate and tropical seas.

Kogia breviceps, (De Blainville) Gray. Pygmy Sperm Whale. Temperate and tropical seas.

Suborder MYSTICETE.—The Whalebone Whales.

Family BALÆNIDÆ.

Rhachianectes glaucus, Cope. Devil-fish; Gray Whale. Pacific coast of North America.

Agaphelus gibbosus, Cope. Scragg Whale? North Atlantic.

Megaptera longimana, (Rudolphi) Gray. Humpback Whale. North Atlantic Ocean.

Megaptera bellicosa, Cope. Caribbean Sea.

Megaptera versabilis, Cope. Humpback Whale. Pacific coast of North America.

Physalus antiquorum, Gray. Finback Whale; Razor-back. North Atlantic Ocean.

Balænoptera rostratus, (Müller) Gray. Pike Whale (? Grampus of New England fishermen). North Atlantic Ocean.

Balænoptera Davidsoni, Scammon. Finback Whale. Northwestern coast of the United States.

? *Balænoptera robustus*, Lilljeborg. Gräsö Whale. North Atlantic Ocean.

Sibbaldius laticeps, Gray. Rudolphi's Rorqual. North Atlantic Ocean.

Sibbaldius sulfureus, Cope. Sulphur-bottom Whale. Pacific coast of North America.

Sibbaldius velifera, (Cope). Finback Whale. Pacific coast of North America.

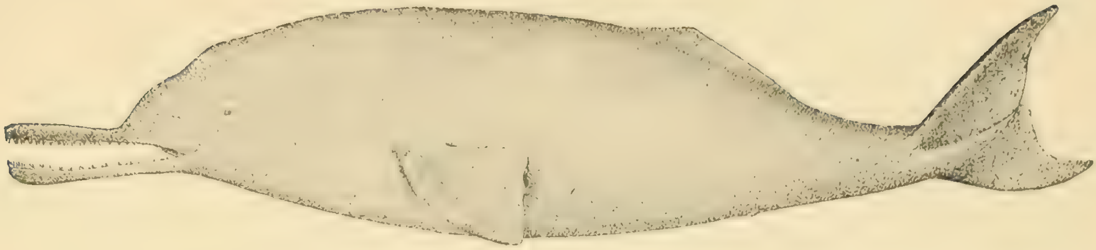
Sibbaldius tuberosus, Cope. Mobjack Bay, Virginia.

Sibbaldius tectirostris, Cope. Coast of Maryland.

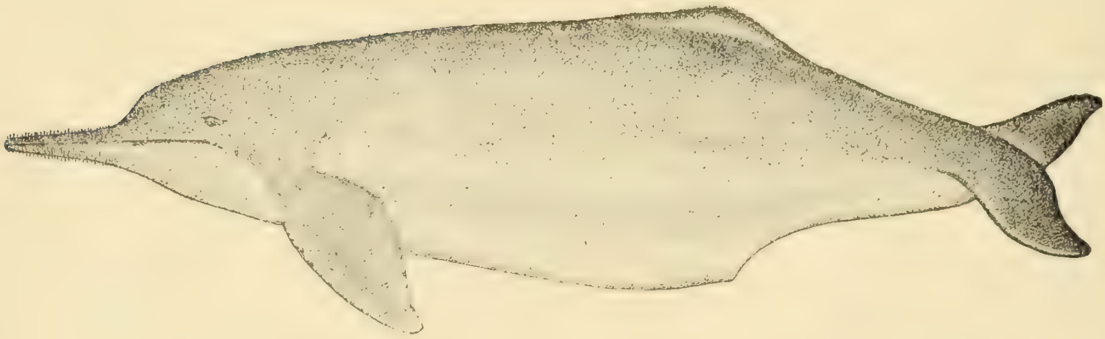
Balæna japonica, Gray. Right Whale of the North Pacific. North Pacific Ocean.

Balæna biscayensis, Gray. Black Whale. Right Whale of the North Atlantic. Temperate North Atlantic.

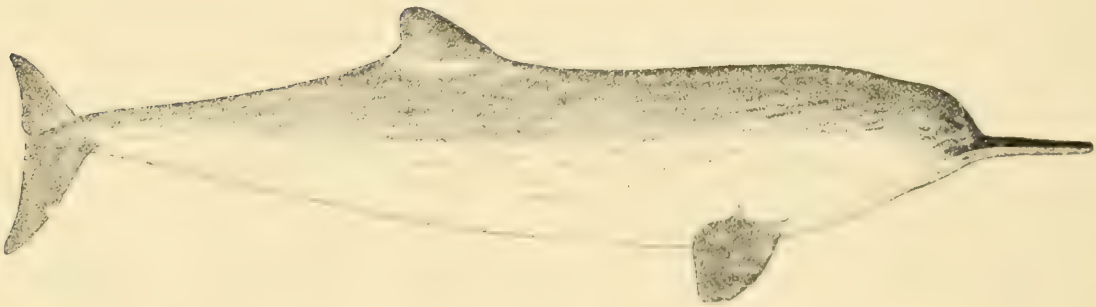
Balæna mysticetus, Linné. Bowhead Whale. Arctic seas.



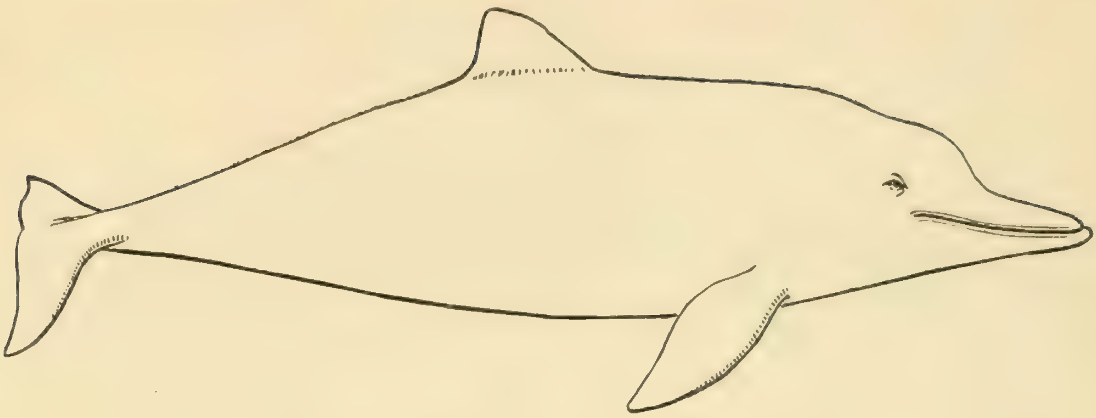
1. *Platanista gangetica*, (Lebeck) Wagler. The Susu.
Length, 8 feet. (After Eschricht.)



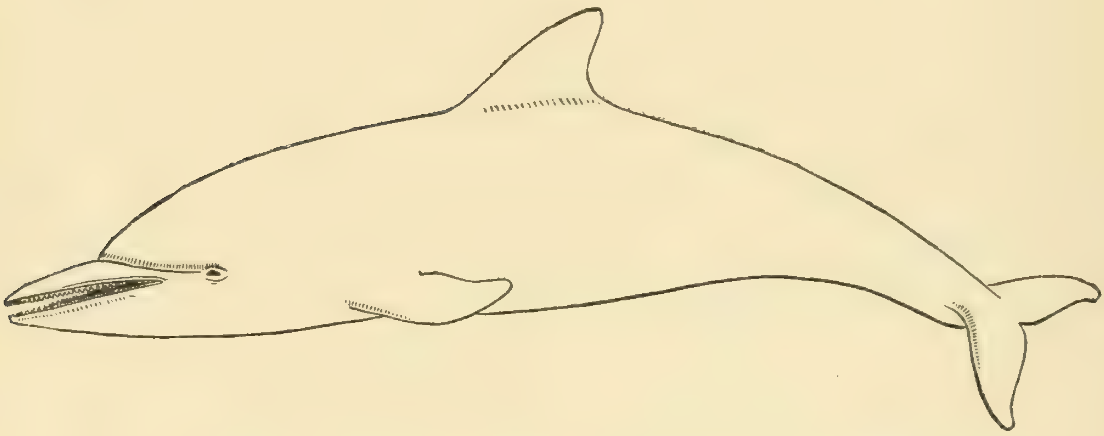
2. *Inia Geoffroyi*, (Desmarest) Gray. The Inia. (Young specimen.)
Length, 8 feet. (After F. Cuvier.)



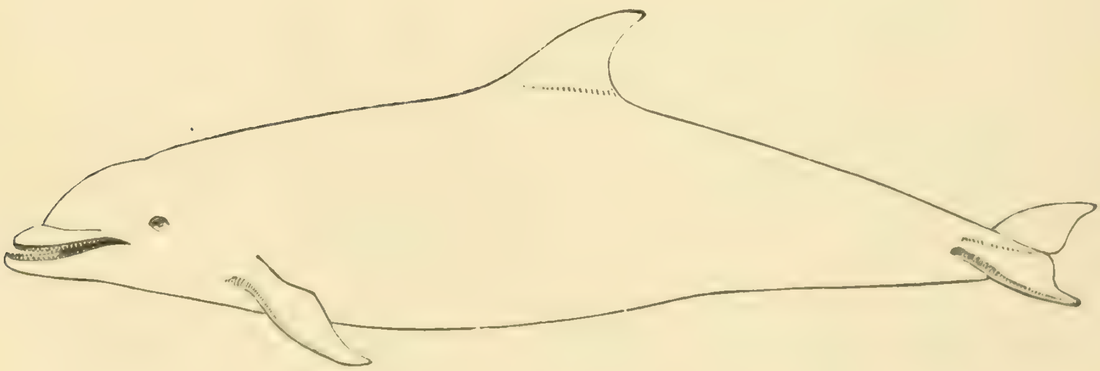
3. *Pontoporia Blainvillei*, (Gervais) Gray. The Pontoporia.
Length, 5 feet. (After Malm.)



4. *Sotalia fluviatilis*, (Gervais). River Dolphin.
Length, 5 feet. (After Gervais.)

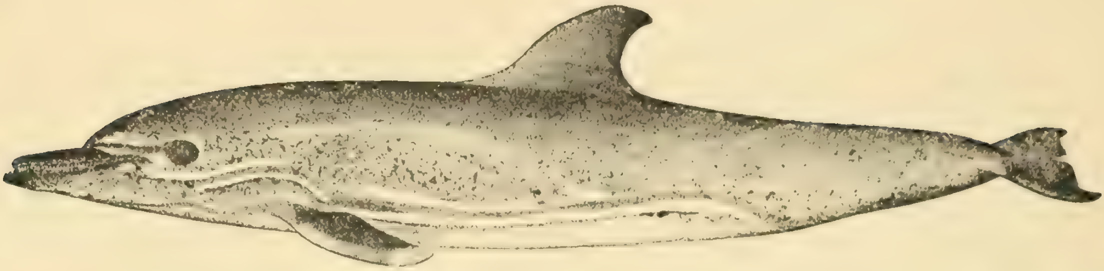


5. *Steno perspicillatus*, Peters. Long-beaked Dolphin.
Length, 8 feet. (?) (After Peters.)

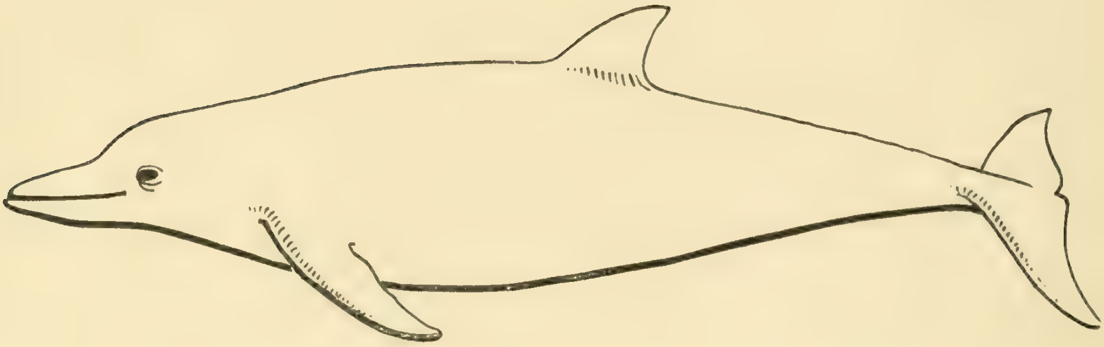


6. *Tursiops tursio*, (Bonnaterre) Van Ben. and Gervais. Common Bottle-nose Dolphin.
Length, 11 feet. (After Flower.)

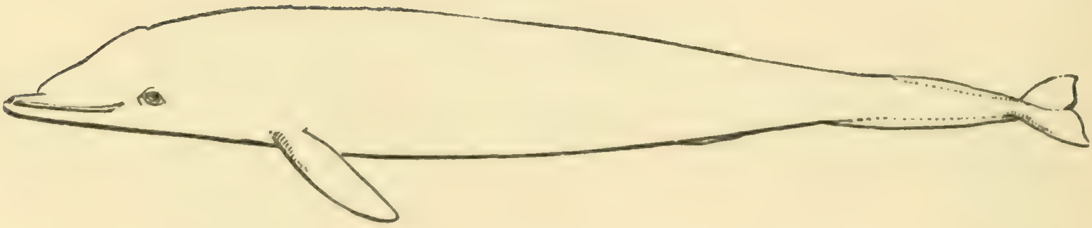
GENERA OF CETACEANS.



7. *Delphinus delphis*, Linné. Common Dolphin.
Length, 6½ feet. (From a sketch by J. H. Emerton.)

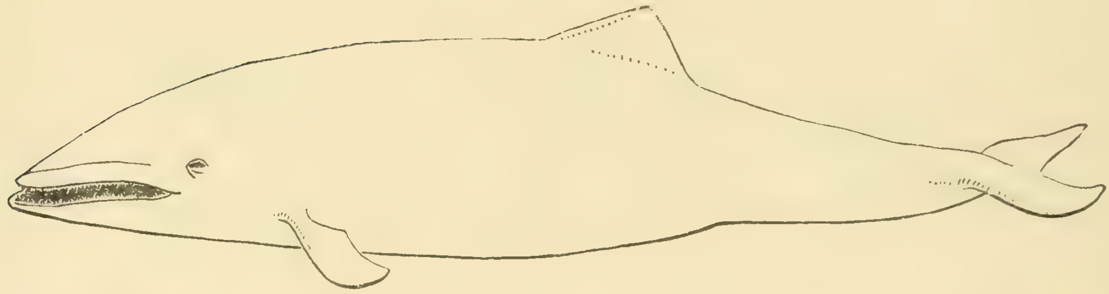


8. *Prodelphinus punctatus*, (Gray) True. Spotted Dolphin.
Length, 6 feet. (After Gray.)



9. *Leucorhamphus borealis*, (Peale) Dall. Right-whale Porpoise.
Length, 8 feet. (From a sketch by William H. Dall.)

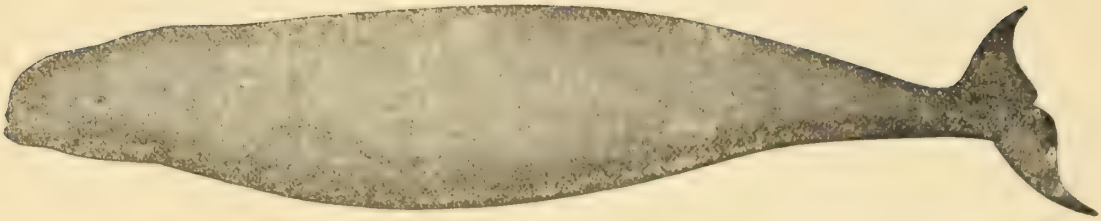
10. *Lagenorhynchus gubernator*, Cope. Striped Dolphin. (Young.)
Length, 7 feet. (?) (From a photograph by the U. S. Fish Commission.)



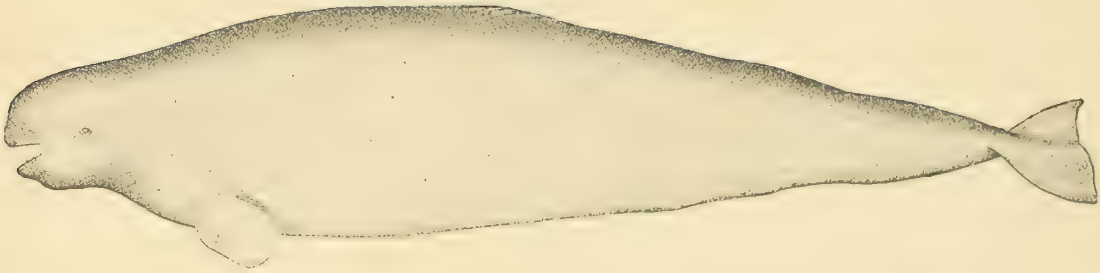
11. *Cephalorhynchus Heavisidei.* White-marked Porpoise.
Length, 5 feet. (After Rapp.)

12. *Phocæna communis*, Lesson. Common Harbor Porpoise.
Length, 5 feet. (From a photograph by the U. S. Fish Commission.)

GENERA OF CETACEANS.



13. *Neomeris phocænoides*, (Cuvier) Gray. The Nameno-juo.
Length, 4 feet. (After Schlegel.)

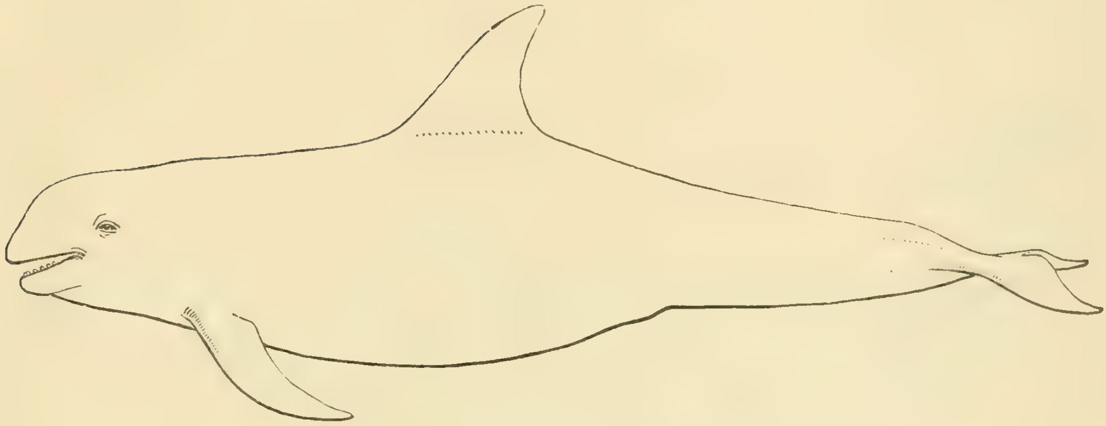


14. *Delphinapterus leucas*, (Pallas). White Whale.
Length, 12 feet. (After a photograph by the U. S. Fish Commission.)

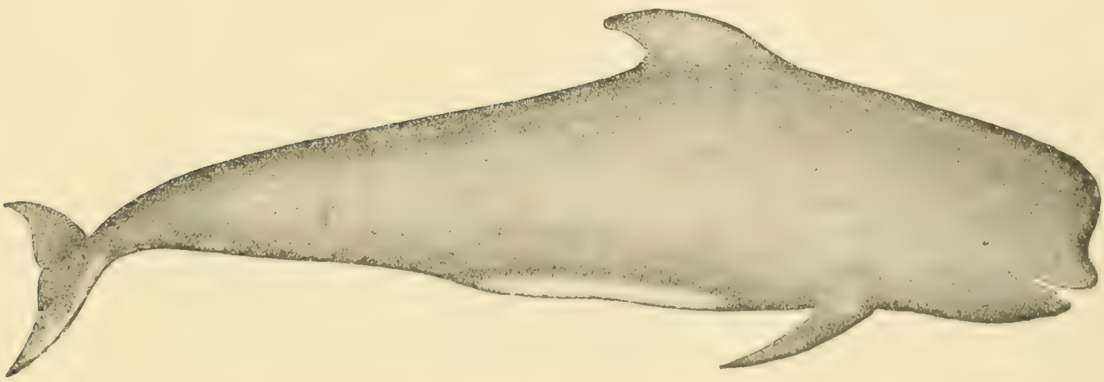
15. *Monodon monoceros*, Linné. Narwhal.
Length of body, 16 feet; length of tusk, 8 feet. (Modified from F. Cuvier.)

GENERA OF CETACEANS.

16. *Orcella fluminalis*, Anderson. Indian River-dolphin.
Length, 6 feet. (?) (After Anderson.)



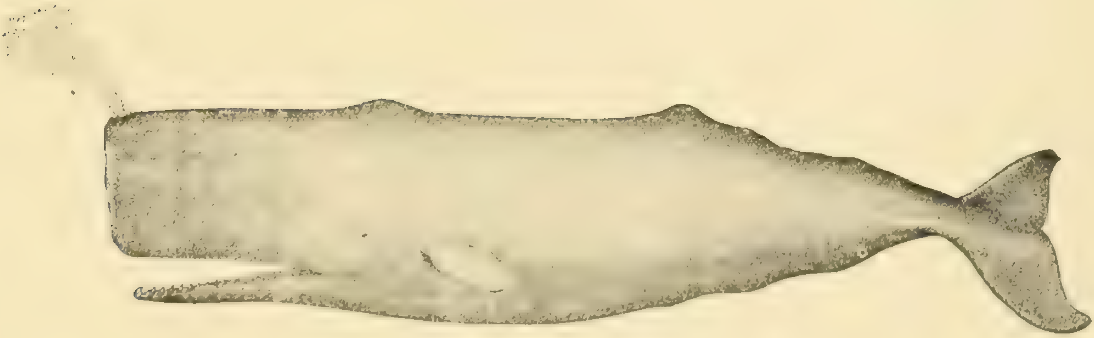
17. *Grampus griseus*, (Cuvier) Gray. Grampus.
Length, 10 feet 6 inches. (After Flower.)



18. *Globiocephalus melas*, (Traill). Blackfish.
Length, 19 feet. (After Flower.)

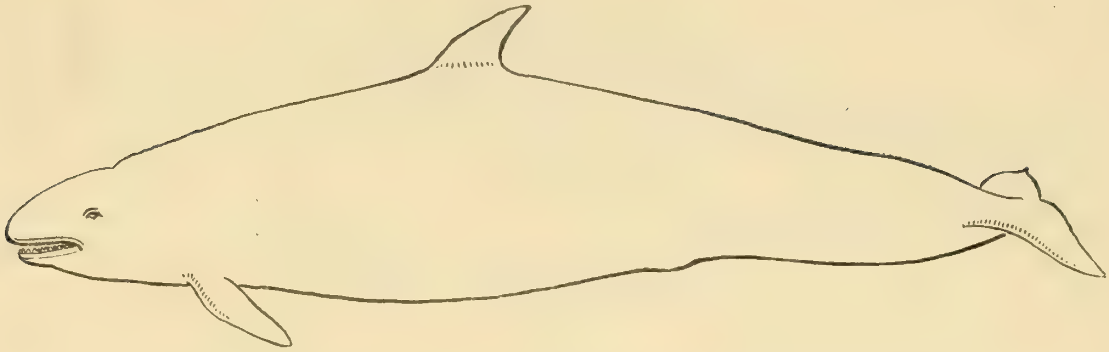
19. *Pseudorca crassidens,* (Owen) Reinhardt. False Killer.
Length, 16 feet. (After Reinhardt.)

20. *Orca atra,* Cope. Killer.
Length, 20 feet. (After Scammon.)



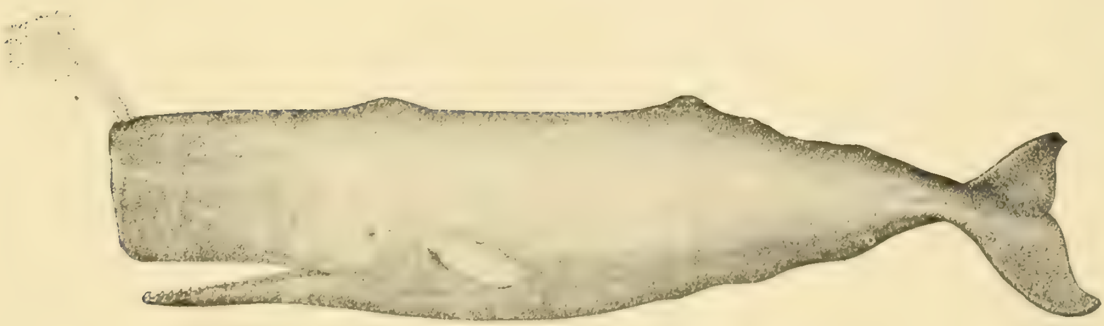
21. *Physeter catodon,* Linné. Sperm Whale.
Length, 60 feet. (After Scammon.)

GENERA OF CETACEANS.



19. *Pseudorca crassidens*, (Owen) Reinhardt. False Killer.
Length, 16 feet. (After Reinhardt.)

20. *Orca atra*, Cope. Killer.
Length, 20 feet. (After Scammon.)



21. *Physeter catodon*, Linné. Sperm Whale.
Length, 60 feet. (After Scammon.)

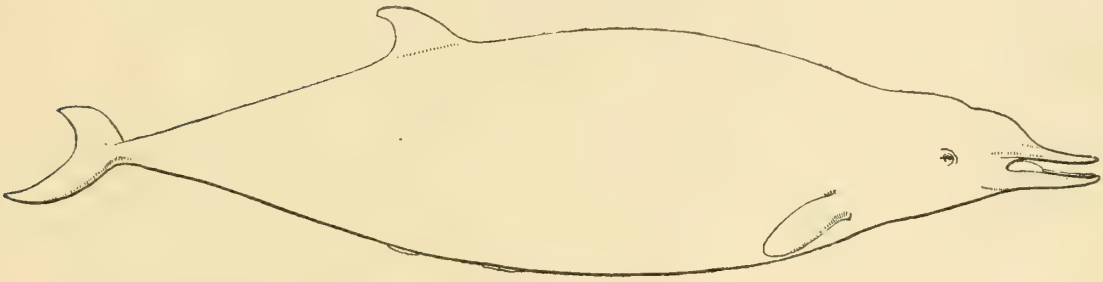
GENERA OF CETACEANS.

22. *Kogia breviceps*, (Blainville) Gray. Pygmy Sperm Whale.

Length, 8 feet, 6 inches. (From photographs by the U. S. Fish Commission of a specimen captured at the U. S. Life Saving Station, Spring Lake, New Jersey, and now in the U. S. National Museum.)

23. *Ziphius novæ-zealandiæ*, Von Haast.

Length, 20 feet. (After Von Haast.)



24. *Mesoplodon Sowerbiensis*, (Blainville) Gervais. Sowerby's Whale, female.

Length, 11 feet. (After Dumortier.)

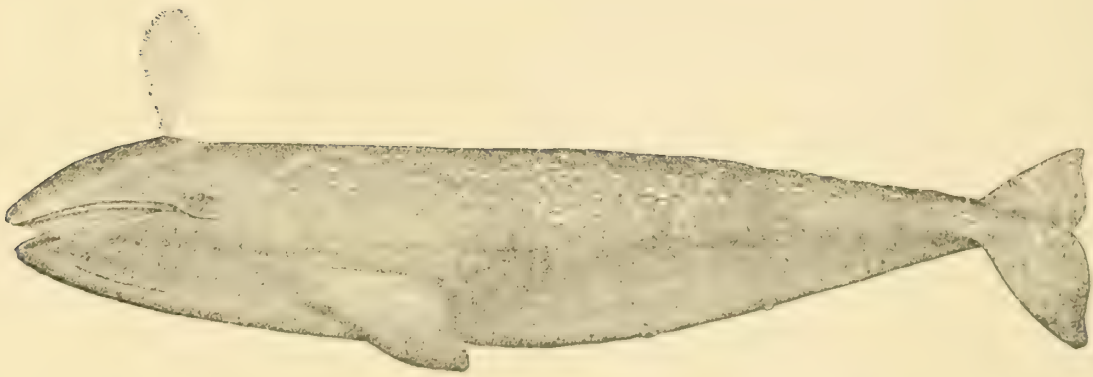
24*a*. Head of male Sowerby's Whale.

(After Andrews.)

GENERA OF CETACEANS.

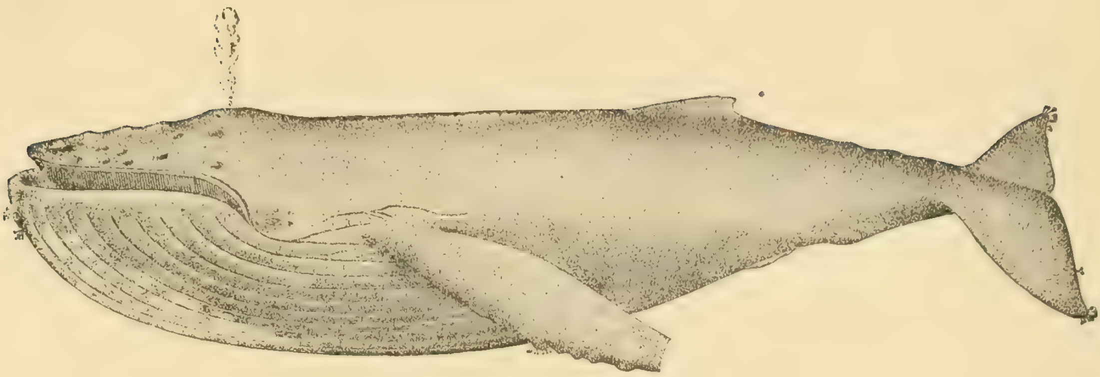
25. *Berardius Arnuxi,* Duvernoy. Arnux's Whale.
Length, 29 feet. (After Knox.)

26. *Hyperoödon rostratus,* (Chemnitz) Wesmael. Bottlenose Whale. (Female.)
Length, 30 feet. (After Wesmael.)

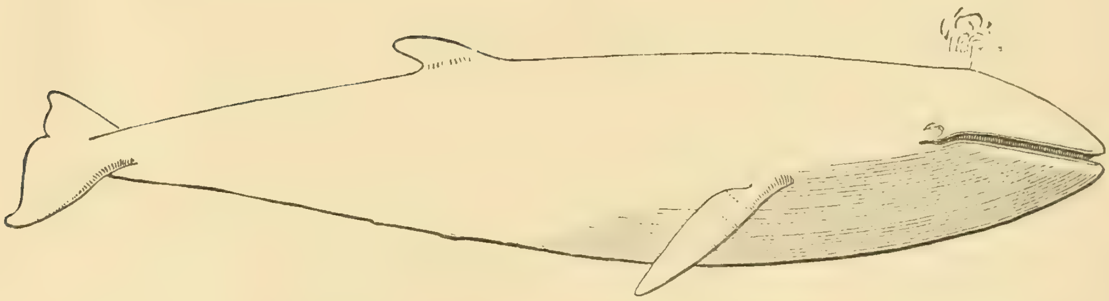


27. *Rhachianectes glaucus,* Cope. California Gray Whale.
Length, 44 feet. (After Scammon.)

GENERA OF CETACEANS.



28. *Megaptera versabilis*, Cope. Pacific Humpback Whale.
Length, 48 feet. (After Scammon.)



29. *Balænoptera Davidsoni*, Cope. Little Piked Whale.
Length, 30 feet. (After Scammon.)

30. *Physalus antiquorum*, Gray. Common Fin-back Whale.
Length, 70 feet. (After Sars.)

31. *Sibbaldius reliferus*, (Cope). Pacific Finback Whale.
Length, 80 feet. (After Scammon.)

32. *Balæna mysticetus*, Linné. Bowhead Whale.
Length, 60 feet. (After Scammon.)

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right	8, 17, 21, 23
sperm	18, 20, 22
sulphur-bottom	8, 17, 21, 23
scragg	17, 20, 22
toothed	19
white	18, 20, 22
whalebone	20, 22
Whalebone	10
Whistling	9
Ziphiidæ	20, 22
Ziphius	17, 20
grebnitzkii	22
cavirostris	22
semijunctus	22

XL.—STATEMENTS CONCERNING THE FISHERIES OF SEVERAL DIFFERENT COUNTRIES.

[Compiled from the Consular Report for 1882 and 1883.]

1.—THE PILCHARD FISHERIES OF FALMOUTH, ENGLAND, IN 1882.

By HOWARD FOX, *Consul.*

The decadence of the seine fishery is more and more marked. The drift-boats again contributed a large portion of the catch, and were again especially successful at the close of the season when fishing at a distance from the curing places. Owing to the more efficient arrangements for preserving the fish, most of these distant catches turned out better than in some former years. Increased attention was given to pickling instead of dry-salting, with satisfactory results, but we regret that some curers remain careless in preparing fish for export, which is a short-sighted policy.

The quantity of pilchards exported during the season of 1882 was 8,317 hogsheads (which included about 1,000 hogsheads caught in 1881), as against 13,963 hogsheads shipped during the previous season. The season of 1882 yielded less for export than either of the eleven preceding years. The prices realized by the curers, the ports to which the fish were exported, and some other interesting particulars relating to this fishery are shown in the following table:

Summary of pilchards exported from 1870 to 1882.

Years.	Genoa.	Leghorn.	Civita Vecchia.	Naples.	Bari.	Ancona.	Venice.	Total.	Price per hogshead to curers.	
	Hhds.	*Hhds.*	*Hhds.*	*Hhds.*	*Hhds.*	*Hhds.*	*Hhds.*	*Hhds.*	*Shillings.*	
1870	2,623½	583½	....	1,548½	100	76	1,117	6,048½	60	to 90
1871	15,551½	7,077	1,092	13,237	1,010½	3,097½	4,545	45,683½	20	68½
1872	802	248	....	88	....	....	....	1,138*	...	...
	10,652½	1,361½	....	2,579½	632	....	2,173½	18,406	38	85
1873†	14,643	4,119½	470	6,263¼	593½	1,862½	2,185	31,019	25	51
1874‡	819	....	....	....	....	....	....	819*	...	...
	4,467½	488	....	1,332½	155½	....	1,094	7,543½	69	89
1875	4,994½	530½	....	1,346½	220½	34	211½	7,337½	52	95
1876	4,732	905½	....	3,138½	100	155	872	9,903	52	100
1877	5,717½	856	....	1,886½	....	98	919	9,477	40	80
1878	7,880	221	....	1,368½	537½	30	272	10,509	30	60
1879	7,855½	1,157½	....	2,698½	....	....	226½	11,937½	41	68
1880	7,577½	744	....	2,847½	350	....	324	11,843	55	80
1881	9,100½	600	....	4,262½	....	....	....	13,963	42	75
1882§	6,563	403	....	1,351	....	....	....	8,317	41	84

* Previous season's fish.
† 653 hogsheads lost on the voyage.
‡ 155½ hogsheads lost on the voyage.
§ About 1,000 hogsheads were previous season's fish.

2.—THE FISHERIES OF NOVA SCOTIA IN 1882

By WAKEFIELD G. FRYE, *Consul-General.*

Of the total production of the fisheries in the Dominion of Canada in 1881, the value of which is officially stated to have been no less than $15,817,162, the product of Nova Scotia for that year was $6,214,781, or fully 39 per cent of the whole. The principal kinds of fish, and their values, were as follows:

Kind.	Value.	Kind.	Value.
Codfish	$2,477,873	Shad	$75,168
Herring	809,907	Halibut	43,102
Mackerel	639,723	Salmon (including salted, smoked, &c.)	37,851
Haddock	406,560		
Hake	258,597		
Pollock	110,453	Total	4,949,130
Alewives	89,896		

The production for the past year is reported to have been considerably less than for 1881, but prices have been higher, especially in the West Indies, and the fish market has been active.

Provision for the payment of a fishing bounty was made during the past year by the Dominion Government, as follows: A bounty of $2 per ton will be paid to Canadian vessels of 10 tons and upwards, having been engaged during three months of the current year in the catch of sea-fish not exempted under the Washington treaty, one-half of such bounty being payable to the owner and the other half to the crew, payment to any vessel not to exceed $160. Fishing boats under 10 tons engaged in fishing for a similar period, and having caught not less than 2,500 pounds of sea-fish per man, are also entitled to a bounty of $2.50 per man, one-fifth of this being payable to the owner and four-fifths to the men.

UNITED STATES CONSULATE-GENERAL,
Halifax, N. S., January 22, 1883.

3.—THE FISHERIES OF PICTOU, NOVA SCOTIA.

By E. JOHNSON, *Consul.*

According to the consular invoices, the value of canned lobsters exported to the United States was $50,781.25, while, according to the custom-house report, it was a little less. A considerable share of this trade, however, went through Halifax. This can be inferred from the fact that the total sale of canned lobsters to the United States from Nova Scotia in 1882 was 2,507,501 pounds, worth $232,274. One-half or more of this was the produce of the consular district of Pictou. The

total exportation from Nova Scotia for the fiscal year 1882 has been 8,153,997 pounds, worth $816,612. From the Dominion of Canada the amount was 14,809,152 pounds, worth $1,431,741. Nova Scotia, therefore, produces more than half of the lobster trade of the Dominion, and this consular district must then produce more than one-fourth of the total production of Canada. England and France are the principal markets for the export trade outside of the United States.

The fisheries are well developed in this district. On the northern shore the lobster canning industries are rapidly developing. We find these establishments all along the coast, at Pugwash, Malagash, Point Brulé, Cape John, Toney River, Cariboo Island, Sandy Cove, three on Pictou Island, Point Betty, Merigomish Ponds, Arisaig, Antigonish, and so on, through the counties of Cape Breton; each of these cost from $3,000 to $4,000, and employs on an average from fifty to sixty people. Each cans on an average per annum at least 150,000 cans; some will probably put up 250,000 cans. Some capital is invested in the herring, cod, mackerel, and salmon fisheries. On the Cape Breton coast the cod fisheries assume much greater importance than on the northern coast.

Statement showing the principal points in the fishing industries of the Pictou consular district in 1881.

County.	Men engaged in fishing.	Nets.	Cod.	Haddock, hake, and pollock.	Herring.	Mackerel.	Canned lobster.	Fish-oil.
	Number.	*Fathoms.*	*Quintals.*	*Quintals.*	*Barrels.*	*Barrels.*	*Pounds.*	*Gallons.*
Inverness	921	34,418	18,529	1,751	5,115	6,390	74,480	4,570
Victoria	1,252	31,120	23,945	1,925	3,590	3,403	....	7,840
Cape Breton	1,570	74,824	33,384	3,075	14,434	4,659	33,600	10,808
Colchester	176	27,112	89	38	107	6	100,000	30
Picton	219	10,953	1,440	16	1,287	398	394,000	524
Antigonish	487	19,318	2,087	815	999	3,084	....	970
Richmond	2,314	145,849	34,616	9,600	14,272	11,123	129,941	14,048
Cumberland	120	4,224	195	164	737	70	157,218	61
Total	7,059	347,868	114,285	17,384	40,541	29,133	1,389,239	38,857

For 1883 these figures must all be increased, especially those for canned lobsters.

UNITED STATES CONSULATE,

Pictou, N. S., August 30, 1883.

4.—THE FISHERIES OF GASPÉ BASIN, QUEBEC, FOR 1883.

By GEORGE H. HOLT, *Consul.*

The trade and navigation of this district are almost entirely connected with the fishery establishments. American fishing-vessels, small in number of late years, risked their enterprise in the waters of the Gulf of the Saint Lawrence, and a fortunate few of them fell in with the fine

schools of mackerel which reappeared, after an absence of many years, on the old fishing-grounds of the Gulf and bays. The cod fishery off the coast of Gaspé is too precarious, and the quality of the fish is not fine enough to satisfy American fishermen, who prefer to risk the perils of the storms and to fish on the banks.

The Jersey fishery establishments, however, carry on the routine of their stations on the coasts of the Gulf year after year, having had but little variation during the past hundred years, except the startling one that of late years the losses on the shipments are of more frequent occurrence. The causes of this may be attributed to the formidable competition of the Norwegian fisheries, in the first place, and recently to the enormous export from Newfoundland (440,529 quintals) between the 1st of August and 15th of December, 1883, being in excess of 1882 by 126,140 quintals, which operated as an avalanche on the foreign markets.

Shippers here paid $4 to $5 per quintal for their export cargoes. Freight to Rio Janeiro was 3*s.* 6*d.* sterling per steamship, and 4*s.* 9*d.* sterling per sailing vessel, per tub, 128 pounds, Portuguese quintal; freight to Naples, 3*s.* 3*d.* sterling per quintal per sailing vessel. During 1883 there were shipped in 21 vessels a total of 54,794 quintals of dry cod, valued at $280,460, destined for the West Indies, Brazil, and Mediterranean ports.

Salmon fishing proved excellent in yield both to the gill-netters and anglers. The net owners received 7 cents per pound for it fresh; and pickled salmon was sold at $20 per barrel.

Whaling is now an industry represented in Canada but by one little schooner of 60 tons, which, after a three months' cruise in the Strait of Belle Isle, returned to port with the oil of four whales (4,800 gallons), which was sent to Montreal and sold at 55 cents per gallon.

The lobster fishery is reported as pursued with so little regard for the future that more effective legislative action will be required for its better preservation. The business of the factories began in May and closed in July. The product of five of them in this district is estimated at 90,000 pounds, in 1-pound cans.

UNITED STATES CONSULATE,
Gaspé Basin, Quebec, January 10, 1884.

5.—THE FISHERIES OF AUSTRALASIA IN 1882.

By O. M. SPENCER, *Consul-General.*

From the report of the commissioners appointed by the Government of Tasmania to inquire into the conditions of the fisheries of that colony we gather the following interesting particulars:

Including the successfully acclimatized European fishes, there are

found in Tasmanian waters one hundred and eighty-eight different species of known sea and river fishes, of which about one-third are regarded as good edible fish. Of the latter, about twenty species are found in sufficient numbers to afford a regular supply for the market. One of the most highly-prized among these, both on account of its size and flavor, is the trumpeter, which is taken at a depth of from 10 to 80 fathoms, and sometimes reaches a weight of 60 or more pounds. Tasmanian fishermen heretofore have depended principally for large returns upon the kingfish, of which, however, owing to its migratory habits, the supply is very uncertain. In 1874–'75 it appeared in such vast numbers that the fish were actually sold for manure, while in 1881 the export was merely nominal.

Shoals of sprats, anchovies, and mackerel periodically visit the Tasmanian waters; but, in the absence of the proper appliances for their capture and preservation, these large stores of wealth have hitherto remained inutilized. Among the crustaceans the most important, commercially, is the crawfish, which is found in great numbers, especially on the eastern coasts; but which, notwithstanding its present abundance, is threatened with total extinction, owing to its wholesale capture irrespective of size or condition.

Referring to the Tasmanian oyster fisheries, which, twenty years ago, were of great commercial importance, the commissioners remarked:

"It is astonishing to contemplate the fact that the quantity then brought to market in one year would now, at current prices, realize a sum of £93,125 (about $450,000); that is, a sum more than the equivalent of the value of the last three years' export of grain, hay, flour, and bran from Tasmania. It is not surprising that those who remember the abundance and commercial value of the original oyster-beds should again and again have attempted to do something to improve this at present neglected and almost obsolete industry, and to claim the aid of Parliament in promoting the welfare of an industry which reasonably might again become of wide national importance.

"When we consider that the only natural beds which may be profitably worked are now to be found in the vicinity of Spring Bay, and that the total yield does not amount to more than one hundred thousand oysters per year, it is humiliating for us to confess that the lesson in oyster culture given to the world by France, many years ago, should in this colony be so thoroughly disregarded."

The commissioners reported that the efforts made from time to time to acclimatize certain species of the salmonidæ had been fairly successful. This was especially true of the salmon trout and the large brown trout. With regard to the successful introduction of the true salmon (*Salmo salar*), the report of the commissioners left the question involved in considerable doubt. They said, however:

"It is satisfactory to find that specimens sent to England for examination have been pronounced to possess the characteristics of true sal-

mon, and the successful acclimatization of this fish from the ova already received may now perhaps be a mere matter of time."

Referring to the development of the fishing industry, the commissioners called attention to the desirability of extending the market for fresh fish, and urged the adoption of improved appliances for the capture and preservation of both the permanent and migrating fish with a view to foreign exportation.

UNITED STATES CONSULATE-GENERAL,
Melbourne, Victoria, May 21, 1884.

6.—THE FISHERIES OF BRITISH INDIA IN 1882.

By H. MATTSON, *Consul-General.*

Fish are found in great abundance and variety in all the waters surrounding India, and, by their extensive and permanent use as an article of food among the native population, they constitute an important factor in the internal economy of the country. They are not, however, an article of export. Some attempts have been made at fish-curing as an industry and as a means of increasing the food supply, which have proved successful and will in all probability soon be developed under the fostering care of some of the local governments. In the Madras presidency there are eleven curing-yards, in which the total curings amounted to 1,734 tons. The fishing industry is particularly well suited to the natives of India, and it is only for the want of enterprise that it has not already become one of great importance and profit.

UNITED STATES CONSULATE-GENERAL,
Calcutta, January 27, 1883.

7.—FISHERIES OF CAPE COLONY, AFRICA.

By JAMES W. SILER, *Consul.*

Little effort is made to utilize the various species and great numbers of fish along the South African coast. In the coast districts sufficient fish are taken to supply a cheap food to the inhabitants of the immediate neighborhood; but the attempts made at curing the fish are of the most primitive kind, and the only exports of this commodity from the seaports, worth naming, are to Mauritius. Some years ago whale fisheries were carried on to some extent on the southern and southeastern coasts of the colony; but latterly whales have ceased to frequent these waters, and the amount of sperm-oil now taken is trifling. South African rivers, as a rule, are singularly destitute of fish useful for table or sporting purposes.

UNITED STATES CONSULATE,
Cape Town, October, 1883.

8.—THE FISHERIES OF FRANCE IN 1880, '81, AND '82.

By GEORGE WALKER, *Consul-General.*

The following tables are summarized from reports published in the Official Journal, showing the condition of the French fisheries during 1880, '81, and '82.

Quantities of fish caught.

Kinds.	1880.	1881.	1882.
Codfish, Newfoundland .... pounds..	40, 534, 316	38, 992, 652	39, 257, 652
Codfish, Iceland .... do...	37, 105, 028	21, 378, 381	26, 488, 792
Herring .... do...	74, 267, 037	86, 219, 568	56, 050, 431
Mackerel .... do...	16, 465, 689	12, 937, 890	11, 825, 251
Anchovies .... do...	8, 925, 840	13, 213, 793	3, 592, 723
Other species .... do...	106, 555, 099	110, 117, 757	117, 549, 749
Shrimps, &c .... do...	2, 209, 405	2, 680, 616	2, 291, 592
Total .... do...	286, 062, 414	285, 540, 657	257, 056, 190
Sardines .... number..	628, 478, 248	372, 940, 031	512, 802, 668
Oysters .... do...	144, 552, 625	374, 985, 770	155, 761, 399
Lobsters, crabs, &c .... do...	1, 398, 454	1, 905, 691	1, 564, 220
Total .... do...	774, 429, 327	749, 831, 492	670, 128, 287
Mussels .... bushels..	1, 416, 253	1, 393, 090	2, 612, 767
Other shell-fish .... do...	525, 944	591, 446	978, 857
Total .... do...	1, 942, 197	1, 984, 536	3, 591, 624
Sea-weed* .... cubic yards..	2, 502, 470	2, 802, 326	3, 104, 110

* Sea-weed is used for preserving and curing fish, but this method is considered much inferior to packing in salt. It is also used to a great extent for manuring lands adjacent to the coast.

Value of fish caught.

Kinds.	1880.	1881.	1882.
Codfish, Newfoundland	$1, 241, 752	$1, 521, 275	....
Codfish, Iceland	1, 323, 372	1, 134, 185	....
Coast fisheries, including herring and mackerel	14, 209, 986	13, 299, 861	....
Total*	16, 775, 110	15, 955, 321	$17, 941, 859

* The decrease in 1881 and increase in 1882 is due largely to the difference in the amount of sardines taken.

Number of men and vessels employed, and tonnage of the vessels.

	1880.	1881.	1882.
Men:			
Cod fisheries, Newfoundland	5, 740	5, 165	....
Cod fisheries, Iceland	4, 556	3, 436	....
Coast fisheries	72, 488	72, 274	....
Total	82, 784	80, 875	83, 845
Vessels:			
Cod fisheries, Newfoundland	147	137	....
Cod fisheries, Iceland	269	202	....
Coast fisheries	22, 320	21, 786	....
Total	22, 736	22, 125	22, 891
Tonnage of vessels:			
Cod fisheries, Newfoundland	23, 588	21, 083	....
Cod fisheries, Iceland	24, 729	19, 652	....
Coast fisheries	109, 472	108, 562	....
Total	157, 789	149, 297	156, 287
Persons fishing along shore without boats	....	55, 485	52, 954

Herring.—During the season of 1881 herring were abundant, and 11,952,531 pounds more were caught than in 1880, with an increased value of $129,538.

This fishery would have been more productive but for the bad weather in the English Channel and the North Sea, which occasioned the loss of vessels having on board full cargoes of fish. The port of Boulogne suffered severely, having lost eight of its vessels, together with their crews and cargoes. The vessels that escaped the storms were obliged to take refuge in the neighboring ports, in which they had to remain some time for repairs.

Coast fisheries.—The sardine fishery in 1881 was much worse than usual, decreasing more than one-third both in catch and value. The fish came late on the coast, and in certain quarters made only a short stay, while in other regions they scarcely appeared at all.

The difficulty that fishermen encounter in selling their products on the spot is the principal reason for the low price of these products in some localities.

The "*seines belot*" have continued to give excellent results. On that account their number has increased in the Douarnenez quarter, in Finistère, where this apparatus has been especially employed.

The result of the fishing for fresh fish was superior in 1881 to that of the preceding year, but the receipts were less in value by $157,078, owing to falling prices in certain markets.

In some quarters of the west coast the fishermen have replaced their ancient vessels by those of larger tonnage, thus enabling them to go farther out to sea; and this has proved practically a success, as is demonstrated by the increased catch of fish.

Cod fisheries of Newfoundland.—The following table shows the statistics of the French cod-fisheries here during the three years named:

	1880.	1881.	1882.
Number of men employed	5,740	5,165	....
Number of vessels	147	137	....
Tonnage of vessels	23,588	21,083	....
Number of pounds caught	40,534,316	38,992,652	39,257,652
Value	$1,241,752	$1,521,275	....

As soon as the vessels arrived at the fishing grounds they were able to occupy the places assigned to them, and the fishing began immediately after the first work of installation. In the month of August, 1881, the product of the fisheries was sufficient only for the food of the crews. In fact, that month was particularly bad, owing to the frequent and violent northeast gales, accompanied by dense fogs and heavy rains, which rendered the drying of the fish very difficult. However, the results at the end of the season of 1881 were better than those of the preceding years, and the captains, with few exceptions, declared themselves satisfied with their fishing. On the other hand, the prices considerably

increased, notwithstanding the abundance of codfish on the market. The sale produced an excess of $279,523 over the preceding year, although the vessels fitted out were ten less in number.

The commander of the station of Newfoundland communicated the good results which the English obtained by the use of nets called "traps." This apparatus was tried by some of the French fishermen, and the trial proved fully satisfactory. This mode of fishing, independent of drag-nets and lines of all kinds, gave rich returns, with little fatigue to the crews.

Cod fisheries of Iceland.—This table, as with Newfoundland, shows partial statistics of the French cod-fisheries near Iceland.

	1880.	1881.	1882.
Number of men employed	4, 556	3, 436	....
Number of vessels employed	269	202	....
Tonnage of vessels	24, 729	19, 652	....
Number of pounds caught	37, 105, 028	21, 378, 381	26, 488, 792
Value	$1, 323, 372	$1, 134 185	....

The exceptional cold of the winter of 1880–'81, and the presence of icebergs upon the east coast until the end of May, were very prejudicial. Moreover, the continual northeast winds, frequently very violent, rendered fishing nearly impossible. To this was added the absence of jelly-fish, the favorite food for the codfish, which were driven farther south on account of the ice. The month of April was especially disastrous, three schooners being wrecked upon the coast, and two others were lost with their crews.

Upon the west coast, during the season of 1881, where the icebergs were not frequently met with, the weather was favorable from July 20 to August 10. The vessels which remained as usual upon this coast during the twenty days above-mentioned, captured an abundance of fish and made good profits. The fish captured were large and of good quality.

Algerian coast fisheries.—In the French colony of Algeria the results of the coast fisheries were less favorable in 1882 than in 1881. The following table gives some comparative statistics:

	1881.	1882.	Decrease in 1882.
Fishermen	5, 105	4, 916	189
Boats	1, 173	1, 044	129
Tonnage	3, 573	3, 258	315
Value	$834, 881	$784, 149	$50, 732

This diminished value was chiefly occasioned by the fact that the catch of the choicer kinds of fish was less abundant in 1882 than in 1881. This brought about a decreased value of the total catch, although the quantity secured was greater than in the preceding year.

UNITED STATES CONSULATE-GENERAL,

Paris, France, February 21 *and December* 14, 1883.

9.—THE FISHERIES OF AMSTERDAM IN 1882.

By D. ECKSTEIN, *Consul.*

The statements and tables of this article are based largely upon a report recently made by the board of fisheries of the Netherlands, for the year 1881, relating to the Dutch sea and coast fishing interests.

The herring catch of 1881 was not so great as that of the previous year, but as the prices realized for the article were so much higher, the total value of the catch exceeded that of former years, and amounted to nearly 4,000,000 florins* [$1,540,000]. The best foreign markets for these herring are South Germany, Belgium, and the United States. A sharp competition from France in the export trade of the article was met during the past two years in the Russian market, especially also in that of Stettin.

Respecting the quality of the Dutch herring, it seems worth noticing that they are held somewhat superior to all others, and are preferred in the trade even to the Scotch article, and this principally on account of the particular care and attention paid to their preparation and assorting, and they consequently command usually a slightly higher price of about from 5 to 10 per cent.

The craft now chiefly employed in the sea and coast fisheries of this country consist of luggers and cutters. Sloops and the so-called "hockers," formerly much in use, have been almost entirely abandoned.

Before 1880 no herring were shipped to the United States in full casks (tuns), but invariably in "sixteenths;" but in that year whole casks were first exported, and in the following year, 1881, the exports in whole casks amounted to 1,800. The difference in the cost of barrels, labor, freight, &c., between whole casks and "sixteenths" is estimated to be about 7 florins [$2.70] per tun or cask; or, in other words, a whole cask of herring can be furnished to the American trade at about 7 florins less than 16 of the small kegs.

Product of the herring fisheries in the North Sea from 1872 *to* 1881, *inclusive.*

Years.	Product of sea fisheries.		Product of coast fisheries.		Total product.
	Pickled.	Fresh.	Pickled.	Fresh.	
	Tuns.	*Number.*	*Tuns.*	*Number.*	*Number.*
1872	60, 438	1, 655, 000	22, 248	39, 350, 000	97, 969, 000
1873	77, 406	2, 710, 000	39, 962	52, 295, 000	135, 072, 000
1874	66, 122	1, 349, 000	46, 519	27, 582, 000	105, 003, 000
1875	59, 486	826, 000	42, 487	19, 439, 000	89, 097, 000
1876	56, 103	1, 021, 000	58, 221	37, 578, 000	114, 766, 000
1877	71, 585	2, 013, 000	69, 414	41, 748, 000	137, 791, 000
1878	70, 356	2, 628, 000	41, 176	33, 094, 000	111, 557, 000
1879	78, 103	1, 764, 000	87, 750	48, 652, 000	163, 300, 000
1880	134, 275	9, 989, 000	83, 724	66, 718, 000	227, 135, 000
1881	110, 116	3, 323, 000	88, 788	57, 804, 000	197, 573, 000

*A Dutch florin = $38\frac{1}{2}$ cents; a kilogram = $2\frac{1}{5}$ pounds; an anker = 5 pecks (all approximately).

The total number of herring representing each year's product, as appearing in the above statement, is not supposed to be entirely correct, as not all tuns or casks contain an equal number of herring, but is based upon an estimate.

The average contents of each tun or cask of pickled herring is computed at 715 pieces as relating to the sea fisheries, and at 650 pieces in respect to the coast fisheries.

Exports of pickled or salted herring, and the countries whither exported, from 1879 to 1882, inclusive.

Years.	Germany.	Belgium.	Russia.	Hamburg.	United States.	Total exports, including other countries.
	Tuns.	*Tuns.*	*Tuns.*	*Tuns.*	*Tuns.*	*Tuns.*
1879	57, 074	10, 506	20	4, 714	6, 627	90, 841
1880	91, 513	19, 253	200	9, 820	10, 240	138, 986
1881	85, 075	24, 860	440	5, 535	16, 220	134, 620
1882	95, 000	18, 000	1, 200	4, 200	17, 000	140, 000

Great quantities of fresh herring are not at once salted and prepared for export as pickled herring, but are smoked or dried (being known to the trade as "bokking") and prepared for export, particularly to Belgium and Germany.

As an evidence of the great importance of the marine resources of Holland aside from the herring fisheries, and in order to show to what extent these resources are being utilized, the following statistical tables are given, showing the exports for several years of fresh sea-fish, codfish, and stock-fish; also of anchovies, shrimps, and oysters:

Exports of fresh sea-fish from 1872 to 1882, inclusive.

[Officially valued at 12 florins per 100 kilograms.]

Years.	To Belgium.	To Germany.	Total exports, including other countries.	Years.	To Belgium.	To Germany.	Total exports, including other countries.
	Kilograms.	*Kilograms.*	*Kilograms.*		*Kilograms.*	*Kilograms.*	*Kilograms.*
1872	2, 617, 000	420, 000	3, 120, 000	1878	4, 671, 000	603, 000	5, 353, 000
1873	4, 327, 000	633, 000	5, 459, 000	1879	5, 952, 000	416, 000	6, 638, 000
1874	4, 456, 000	583, 000	5, 548, 000	1880	6, 445, 000	443, 000	6, 959, 000
1875	5, 491, 000	470, 000	6, 911, 000	1881	3, 943, 000	463, 000	4, 800, 000
1876	5, 452, 000	375, 000	6, 779, 000	1882	3, 424, 000	342, 000	4, 300, 000
1877	3, 637, 000	375, 000	4, 236, 000				

Exports of salted codfish and stock-fish from 1873 to 1882, inclusive.

Years.	Salted codfish.*	Stock-fish.†	Years.	Salted codfish.*	Stock-fish.†
	Kilograms.	*Kilograms.*		*Kilograms.*	*Kilograms.*
1873	764, 000	1, 539, 000	1878	600, 000	1, 218, 000
1874	676, 000	1, 143, 000	1879	893, 000	1, 428, 000
1875	580, 000	1, 362, 000	1880	533, 000	1, 024, 000
1876	943, 000	1, 292, 000	1881	575, 000	1, 546, 000
1877	973, 000	1, 293, 000	1882	391, 000	971, 000

* Officially valued at 10 florins per 100 kilograms.
† Officially valued at 20 florins per 100 kilograms.

Catch, export, &c., of anchovies from 1872 *to* 1881, *inclusive.*

[Officially valued at 28 florins per 100 kilograms.]

Years.	Catch.	Export.	Stock on December 31 of each year.	Years.	Catch.	Export.	Stock on December 31 of each year.
	Ankers.	*Ankers.*	*Ankers.*		*Ankers.*	*Ankers.*	*Ankers.*
1872	9,000	14,900	14,200	1877	6,000	17,000	43,700
1873	30,000	31,000	13,200	1878	1,400	28,300	22,000
1874	40,000	26,200	27,000	1879	3,000	19,800	5,200
1875	55,000	29,000	53,000	1880	1,000	4,300	1,900
1876	40,000	38,000	55,000	1881	15,000	12,200	4,700

Exports of shrimps from 1872 *to* 1881, *inclusive.*

[Officially valued at 10 florins per 100 kilograms.]

Years.	To England.	To Belgium.	Total exports.	Years.	To England.	To Belgium.	Total exports.
	Kilos.	*Kilos.*	*Kilos.*		*Kilos.*	*Kilos.*	*Kilos.*
1872	577,000	88,000	665,000	1877	647,000	124,000	771,000
1873	479,000	130,000	609,000	1878	716,000	214,000	946,000
1874	209,000	129,000	338,000	1879	511,000	251,000	762,000
1875	197,000	350,000	547,000	1880	417,000	247,000	667,000
1876	437,000	155,000	592,000	1881	1,020,000	140,000	1,173,000

Statement showing the extent of oyster culture and the exports of oysters, from 1876 *to* 1881.

	Oysters.
Delivered in different Dutch markets for home consumption	2,297,000
Exported to Germany	4,559,000
Exported to Belgium and France	4,199,000
Exported to England	10,788,000
Total in 1881	31,843,000
Total in 1880	16,589,000
Total in 1879	11,116,000
Total in 1878	7,193,000
Total in 1877	9,679,000
Total in 1876	36,580,000

The waters along the Dutch coast and in the Zuyder Zee abound with many other sorts of excellent fish, the yearly catch of some of which is quite large, supplying not only the home market but also increasing the export trade in fish.

UNITED STATES CONSULATE,

Amsterdam, Netherlands, September 30, 1883.

10.—THE FISHERIES OF SPAIN IN 1879.

By DWIGHT T. REED, *Consul-General.*

The following statement shows the condition of the fisheries of the Spanish Peninsula at the close of 1879, no later statistics being available:

Fish-curing establishments:	
Number of establishments	785
Value of establishments (7,149,278 pesetas)	$1,379,810
Number of vessels	1,620
Tonnage	5,966
Value of vessels (779,350 pesetas)	$150,415
For the supply of fresh fish, and not connected with the above establishments:	
Number of nets and other contrivances for taking fish	95,458
Value (6,634,114 pesetas)	$1,280,385
Number of vessels	14,017
Tonnage	40,184
Value of vessels (7,779,577 pesetas)	$1,501,460
Total number of persons employed in connection with the establishments and in shipping fresh fish	78,184
Total value of the establishments, vessels, outfits, and apparatus for the supply of fresh fish (22,342,319 pesetas)	$4,312,070

No returns exist as to the amount or value of the products.

Atun or tunny.—I make special mention of the atun or tunny, a very large fish of the mackerel family, as it is not found in American waters, and as it is one of the principal productions of the Peninsular fisheries. This fish weighs from 100 to 300 pounds. It is migratory in its habits, and enters the Mediterranean from the Atlantic during the spring of each year, in large schools, for the purpose of reproduction, returning afterward to the ocean. It is taken with strong seines, and when surrounded by the net each fish is lifted on board the vessel by means of poles with a stout hook at the end. The flesh is highly esteemed and is eaten fresh; also it is cured in oil in large quantities.

For the purpose of taking the tunny the coasts of the Peninsula are divided into districts, and each districtis leased by the Government, at public auction, to the highest bidder, for a term of from three to five years. In 1879 the Government received 124,071 pesetas, or $23,945.70, for these leases.

THE CANARY ISLANDS FISHERIES.

On the west coast of Africa, between the twentieth and twenty-ninth parallels of north latitude, there is an immense abundance of fish of many varieties. It is from this source that the Canary Islands derive their supply of fish for salting purposes. Thirty-five schooners of from 30 to 50 tons each, manned by about 700 men and boys, constitute the fishing fleet of these islands. This fleet furnishes annually about

16,500,000 pounds of imperfectly cured fish for the consumption of the inhabitants. It does not appear that any of the fish is exported, with the exception of a small quantity to the island of Cuba. The fishing banks are within the belt of the northeast trade-winds, which blow almost constantly; and so mild is the climate and so moderate the winds that during the four centuries while Spain has possessed the islands not a single fishing vessel, so far as is known, has been lost from stress of weather. The products of this fishery might be greatly increased if larger and more commodious vessels were employed, and if the improved methods of curing practiced by other nations were at the same time generally introduced.

UNITED STATES CONSULATE-GENERAL,
Madrid, *Spain*, *October* 30, 1883.

11.—THE FISHERIES OF MADEIRA IN 1882.

By L. DU PONT SYLE, *Consul.*

The Portuguese peasant seldom eats meat, but vegetables and a morsel of fish form his staple food. The Government lays a heavy tax upon fish, and obtains a considerable part of its revenue from this source. The fisheries, consequently, are but little developed in comparison with what might be done.

Fish of the following kinds are found near the coast of the Madeira Islands: Perch, red mullet, gray mullet, beryx, barracuda, gurnard, sea-bream, pickerel, flag-fish, mackerel, zemdæ, wrasse, pike, herring, codfish, eel, and flat-fish.

The only freshwater fish are eels, of which there are several kinds. They are taken in the mountain streams.

Tunnies of large size are caught in the deep-sea fishing grounds, as also is the cherne. Turtles are taken chiefly during the summer time, and vary in size; they are not so highly prized as the West India turtles, but nevertheless make good soup. Shrimps (camarõens) are sometimes offered for sale. Madeira lobsters are very different in appearance from those in England. Crabs are small and not worth eating. The white-bait (guelros) of Madeira are exceedingly good, and are caught chiefly after heavy rains, when they come in shoals to the muddy waters brought down by the mountain torrents.

At low water innumerable limpets and periwinkles are seen on the rocks, and crabs of every size are scattered around. Sea-urchins with long spines are dangerous to bathers, and have been known to cause serious trouble to those that stepped on them. Occasionally the fishermen bring in curious sea-monsters—the Urgamanta, for instance, the creature described in Victor Hugo's "Toilers of the Sea." This is much dreaded by the boys diving around the ships at anchor, for it comes to

the surface floating on its back, and endeavors to envelop its prey with its large and powerful double flaps, and having done so immediately sinks to the bottom. The octopus (pulvo) sometimes grows to a large size. From this sea-monster the Portuguese fishermen make a soup which they consider a great delicacy.

UNITED STATES CONSULATE,
Funchal, Madeira, May 10, 1883.

12.—THE SEA FISHERIES OF AUSTRO-HUNGARY FROM 1877 TO 1883.

By JAMES RILEY WEAVER, *Consul-General.*

The sea fisheries of Austria are not of great importance, being confined exclusively to the waters of the Adriatic Sea. They employ an average of 10,000 men annually, of which number about 900 are Italian subjects. The average catch of an Austrian fisherman is about half that of an Italian fisherman, but in explanation it should be stated that many Austrians are fishermen only during the best part of the season, and are engaged in farm work or some other employment at other portions of the year. The statistical year extends from April 23 to April 22, forming two fishing seasons, the summer and the winter season. About three-fourths of the catch is consumed near the places where taken. The condition of the Austrian fisheries is not satisfactory, and there is need for some legal protection to this industry by forbidding the use of seines of small meshes and by preventing the fishing for certain species during the period of spawning.

The following tables are based on data varying in slight details. If the data are reliable, the tables may be regarded as approximately correct.

General statistics of Austro-Hungarian fisheries.

Years.	Pieces.*	Weight.	Value.
		Pounds.	
1877–'78	....	....	$970,630
1878–'79	....	....	879,140
1879–'80	7,175,423	17,281,767	799,533
1880–'81	9,905,410	24,184,140	1,140,049
1881–'82	5,400,645	17,954,503	896,115
1882–'83	6,167,021	18,802,676	1,028,733

* Pieces is probably the same as number. In this and the following tables United States denominations have been used instead of the Austrian weights and measures, according to the following equivalents: 1 florin = 45.3 *cents*; 1 kilogram = 2.2046 pounds; and 1 metrical centner = 110.5 pounds.

Quantities of fish, mollusks, shell-fish, &c., taken in 1879–'80.

Kinds.	Amounts.	Kinds.	Amounts.
Sardines ... pounds..	1, 810, 763	Moss mussels ... number..	3, 337, 500
Bream ... do....	1, 429, 541	Ark mussels ... do....	425, 600
Mackerel ... do....	974, 380	Oysters ... do...	60, 807
Perch ... do....	186, 192		
Sea-mullets ... do ..	170, 943	Total ...	3, 823, 907
Eels ... do....	144, 755		
Sea-gudgeons ... do....	131, 937		
Barbels ... do....	122, 765	Crawfish ... number..	327, 383
Roy ... do....	104, 975	Lobsters ... do....	24, 660
Stockern ... do....	85, 195		
Soles ... do....	73, 814	Total ...	352, 043
Sharks ... do....	69, 394		
Anchovies ... do....	57, 460		
Sunfish ... do....	20, 663	Sponges ... number..	400
		Mammals ... do....	8
Total ...	5, 382, 897		

Fishermen, boats, and tackle engaged from 1879 to 1883, reported in half-yearly seasons end-October 22 and April 22.

Season.	Fishermen.	Boats.		Tackle.	
		Number.	Value.	Number.	Value.
Summer, 1879 ...	10, 496	2, 578	$327, 918	60, 660	$493, 927
Winter, 1879–'80 ...	8, 555	2, 336	311, 860	47, 891	356, 959
Summer, 1880 ...	10, 496	2, 671	349, 991	61, 642	497, 731
Winter, 1880–'81 ...	8, 839	2, 419	346, 903	45, 874	336, 124
Summer, 1881 ...	10, 981	2, 688	351, 777	48, 117	479, 074
Winter, 1881–'82 ...	9, 070	2, 422	313, 185	42, 022	315, 678
Summer, 1882 ...	10, 634	2, 813	355, 443	67, 200	510, 865
Winter, 1882–'83 ...	9, 016	2, 447	301, 553	44, 981	321, 924

The fishing boats belong to 118 ports, and in only two instances (Comisa and Grado) does the number exceed 100 boats.

Catch and home consumption from 1879 to 1883, in the same half-yearly seasons.

Season.	Catch.			Home consumption.	
	Pieces.	Weight.	Value.	Pieces.	Weight.
		Pounds.			*Pounds.*
Summer, 1879 ...	4, 363, 755	9, 965, 676	$487, 719	2, 558, 211	6, 092, 685
Winter, 1879–'80 ...	2, 811, 668	7, 316, 091	311, 814	2, 596, 802	4, 878, 722
Summer, 1880 ...	7, 175, 423	17, 281, 767	799, 534	5, 155, 013	10, 971, 404
Winter, 1880–'81 ...	2, 729, 987	6, 902, 373	340, 515	2, 571, 506	5, 131, 237
Summer, 1881 ...	2, 028, 275	11, 071, 550	552, 376	1, 812, 186	6, 670, 403
Winter, 1881–'82 ...	3, 372, 370	6, 882, 953	343, 739	3, 154, 431	5, 652, 414
Summer, 1882 ...	2, 359, 237	12, 314, 664	681, 461	1, 576, 968	6, 336, 250
Winter, 1882–'83 ...	3, 807, 784	6, 488, 012	347, 272	3, 493, 239	5, 996, 309

The number of fishing boats engaged in the trade in Hungary during 1881 was 64, aggregating 136 tons burden and manned by 142 fishermen. The data as to the catch and consumption cannot be given.

Sardine fisheries at Triest.—This industry dates back to 1862, and has developed to about 225 fishing boats, employing about 500 men. Although when compared with the 10,000 boats engaged in fishing for sardines on the coast of France the Triest fisheries seem small, yet

taking into account the short period of their existence much development is shown. The catch is preserved with Italian and French oils, as the Dalmatian oil is not suited to the purpose. About two thirds of the year's product is sent to America, China, and India. The present careless methods of using drag-nets, and the excise duty paid on salt, are a drawback to this fishery. It is surprising that no protective laws are in existence in regard to these sea fisheries, as the river fisheries are carefully regulated by local laws.

UNITED STATES CONSULATE-GENERAL,
Vienna, February 27, 1883, *and February* 25, 1884.

13.—THE FISHERIES OF SYRIA IN 1882.

By JOHN S. ROBESON, *Consul.*

The fisheries along the coast of Syria are neither extensive nor important, the fish caught being of inferior quality. Roach, mullet, and tunny are the principal varieties, and may be taken during all seasons of the year. Fishermen are few, and the amount of capital invested in boats and fishing tackle is small. The fisheries controlled by the governor of Beirut are leased to the highest bidder annually, who receives 20 per cent of the value of all the fish caught in his district. Last year the lessee paid $3,280. The value of the fish is estimated at $20,000. A coarse sponge is found near Beirut, but very little attention is given to sponge-fishing on the Syrian coast.

UNITED STATES CONSULATE,
Beirut, Syria, October 1, 1883.

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